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The Marls and Phosphates of North Carolina

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NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

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RALEIGH, N. C.

PREFACE.

The work of the Experiment Station from the earliest period of its existence, has embraced the chemical examination of natural deposits that might be used for agricultural purposes, as well as of other materials that could be so utilized from the by-products of other industries, and those that could be saved and used by careful management on the farm. The Station has thus been of material assistance in giving a more definite idea of the value of such materials, as well as advice to those who were perhaps unconscious of their proper use.

Since the establishment of the Station in March, 1877, many hundreds of analyses of marls and phosphates have been made. These are collected in this bulletin by Mr. F. B. Carpenter, Assistant Chemist, and such information of the location and extent of the deposits as could be gathered from our records is also inserted. A description of the geological features of the formations, together with their distribution, varieties and uses, are included. A chapter on the manufacture of acid phosphate from mineral phosphates is also appended in order to give a more perfect idea of this very important material.

The complete bulletin, the table of contents of which may be seen on the following page, will be sent to any person who receives only this preliminary notice, and who will make application to the undersigned.

H. B. BATTLE, *Director.*

CONTENTS.

THE MARLS AND PHOSPHATES OF NORTH CAROLINA.

By F. B. CARPENTER, Assistant Chemist.

Introductory.

Of North Carolina's mineral resources there is none which is of so much interest to the agricultural community as her beds of marls and phosphates. These deposits are distributed throughout the eastern portion of the State, and belong to one of the largest formations of the kind in the world. The portions of the Cenozoic and Mesozoic eras, which include these deposits, may broadly be said to extend along the coast of the Atlantic Ocean and the Gulf of Mexico from New Jersey to Texas. While the marls are not as rich in some fertilizing ingredients as the famous green sand marls of New Jersey, and the deposits of phosphates thus far discovered are less valuable than those of South Carolina, the supply is very extensive, and if properly utilized, will prove of material value to the farming community, especially in the eastern portion of the State. These deposits of phosphates and marls are in many cases so closely connected that there is seen a great variety of material, ranging from a nearly pure carbonate of lime containing a trace of phosphate to that of a high grade phosphate with only a small content of carbonate of lime. In addition to phosphate of lime and carbonate of lime, the green sand varieties contain an appreciable percentage of potash. The value of all the different deposits is largely affected by the varying percentages of sand or other worthless material which they may contain. It is the purpose of this bulletin to record in convenient form the analyses of the different marls and phosphates representing the various localities which have been investigated, together with such other information as will be useful in the selection and use for agricultural purposes.

Geological.

The earth's crust is divided into the Archæan, Protozoic, Paleozoic, Mesozoic, Cenozoic, and Psychozoic eras. The marls and phosphates discussed herein belong to the fourth and fifth of these eras —Mesozoic and Cenozoic. The Cenozoic or era of mammals, immediately preceded the Recent formation or age of man. The subdivisions of the Cenozoic era embrace three periods, *Eocene* or period of nearly extinct species; *Neocene* or period of which the species are more than half extinct; and *Pleistocene* or period of which more than half the species are still living. The Triassic and Cretaceous

periods of the Mesozoic era; the Eocene, Neocene, and Pleistocene periods of the Cenozoic era, all have representatives in the deposits of marls and phosphates.

Origin.

In former times the coast line of North Carolina was much farther inland than at present; and it is not difficult to understand how the different varieties of marl, composed as they are chiefly of shells, mollusks and other organic remains, should be found in abundance in a locality which was once the bed of the ocean. The origin of the deposits of hard, soft, and pebble phosphates, however, has been a matter of considerable discussion. Knowing that the chief constituent of bones is phosphate of lime, the presence of large numbers of fossils in these localities indicates that they may be the remains of animal life, but just how they were deposited in the present form can only be a matter of speculation. The most probable explanation of the formation of these apparent mineral deposits is deduced from the different climatic influences and terrestrial disturbances which took place toward the end of the Cenozoic era. It has been suggested that at the close of this era the waters of the ocean were probably somewhat phosphatic. The areas for the most part, where phosphates are now found, were at that time submerged, and in these shallow waters there lived myriads of shell fish, many secreting phosphate as well as carbonate of lime. Fishes of all kinds lived and died in these waters, and their bones, while mostly disappearing, served to increase the amount of phosphate of lime in the lime formation. Gradually the shores emerged from the seas, and while this was taking place came the great geological era—the glacial epoch. The cold of this epoch caused every living creature capable of moving to migrate to the southward. The strongest survived the longest. Many of these sought the swamps and warm estuaries of the Carolinas while others pushed on to Florida, in which places finally, from one cause or another, but generally from the intense cold, they perished and their bones lay there in myriads, some being still well preserved. At this time also the sea was swarming with large numbers of fish, great and small. Many of these also, driven into the warmer waters by the intense cold, died and their bones were added to the growing mass. Then came the melting of the glaciers accompanied by the very large streams which aided in making these formations in the stiller waters. The phosphate of lime in suspension was deposited as an alluvial deposit, and mixed in many cases with lime, clay and sand which were brought down by the same means. The gradual evaporation of these waters brought about the phosphate formation principally in the neighborhood of the rock cavities and fissures of large and small estuaries. These estuaries besides being swarming with life and vegetable matter, were heavily charged with acids and salts, and their continuous concentration ultimately induced different processes of decomposition and final metamorphism.

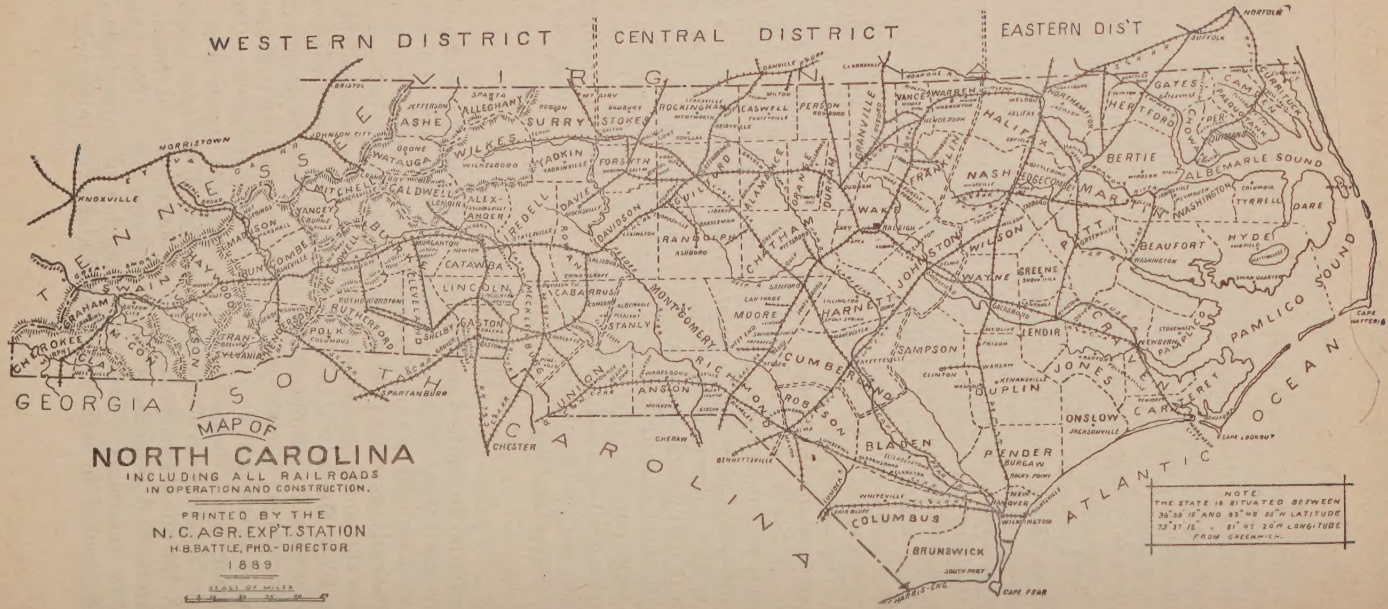
Marls.

Marl is the name which is applied to a variety of earthy deposits of varying composition, containing a considerable percentage of carbonate of lime. The source of lime is usually largely from the remains of marine mollusks and other animals which secrete carbonate of lime. This is especially true of the marls under consideration, and in most cases the remains of shells are readily distinguished. An analysis of oyster shells made at the Experiment Station gave 89.85 per cent. carbonate of lime; another analysis of fresh water shells showed 93.32 per cent. Other varieties of shells have a corresponding composition, and the number of these cretaceous remains is an indication of the amount of lime present in the marl.

The extensive deposits of this material in North Carolina were first brought to general notice in the report by Dr. Emmons of the North Carolina Geological Survey, published in 1852. Each year's work of the survey brought some additional information concerning these localities, but the wide extent of the deposits were not fully recognized or known until after the establishment of the Experiment Station in 1877. Since that time more than four hundred analyses of marl have been made, representing thirty-six counties of the eastern portion of the State. This information has been published from time to time as it was obtained, until at present the character of the marls in different localities seems to be pretty well established. The composition of the different deposits is very variable, as will be seen by the accompanying tables of analyses. Some of the specimens are so mixed with sand as to almost lose their identity, while others in addition to a large percentage of carbonate of lime contain a large amount of phosphate of lime, making them quite valuable as a fertilizer. Still others, especially those of the green sand variety, contain an appreciable amount of potash.

DISTRIBUTION.

Marl is found in limited patches or beds in nearly all the counties of the eastern district of the State (see p. 458 for map of North Carolina), but the outcrop is much more extensive and valuable in some sections than others. The Cretaceous and Eocene varieties are mostly confined to the southeastern portion of the State between the Neuse and Cape Fear rivers, while the Neocene and later formations are much more widely distributed, and being nearer the surface, and so more accessible, have been much more extensively used, and are consequently better known than the earlier formations. They are found throughout a large part of the eastern region from South Carolina to Virginia. In fact they occur in all the counties in eastern North Carolina except those lying between and north of the great sounds, and even here small outcrops have been observed. The western boundary of the main portion of these beds is very nearly represented by a line parallel to and a few miles west of the


WESTERN DISTRICT
CENTRAL DISTRICT
EASTERN DIS'T
VIRGINIA
TENNESSEE
SOUTH CAROLINA
GEORGIA
ATLANTIC OCEAN
MORRISTOWN
KNOXVILLE
BRISTOL
JOHNSON CITY
ASHE
ALLEGHANY
SURRY
STOKES
ROCKINGHAM
CASWELL
PERSON
VANCE
WARREN
GRANVILLE
WATAUGA
WILKES
YADKIN
FORSYTH
GUILFORD
ALAMANCE
ORANGE
DURHAM
FRANKLIN
HALIFAX
NORTHAMPTON
GATES
CHOWAN
PERQUIMANS
PASQUOTANK
CAMDEN
CURRITUCK
NORFOLK
SUFFOLK
MITCHELL
CALDWELL
ALEXANDER
IREDELL
DAVIE
DAVIDSON
RANDOLPH
CHATHAM
WAKE
NASH
EDGECOMBE
MARTIN
BERTIE
HERTFORD
ALBEMARLE SOUND
YANCEY
MADISON
BUNCOMBE
BURKE
CATAWBA
LINCOLN
CABARRUS
MONTGOMERY
MOORE
LEE
JOHNSTON
WILSON
WASHINGTON
TYRRELL
DARE
BEAUFORT
HYDE
PAMLICO SOUND
CRAVEN
PITT
GREENE
WAYNE
HARNETT
GRAHAM
MACON
SWAIN
JACKSON
HAYWOOD
TRANSYLVANIA
HENDERSON
RUTHERFORD
POLK
GASTON
CLEVELAND
RICHMOND
SCOTLAND
ANSON
UNION
CHEROKEE
CLAY
SPARTANBURG
CHESTER
CUMBERLAND
ROBESON
SAMPSON
DUPLIN
JONES
LENOIR
ONSLOW
CARTERET
CAPE LOOKOUT
CAPE HATTERAS
PENDER
BLADEN
COLUMBUS
BRUNSWICK
CAPE FEAR
MAP OF
NORTH CAROLINA
INCLUDING ALL RAILROADS
IN OPERATION AND CONSTRUCTION.
PRINTED BY THE
N. C. AGR. EXP'T. STATION
H. B. BATTLE, PH.D. - DIRECTOR
1889
SCALE OF MILES
NOTE.
THE STATE IS SITUATED BETWEEN
36° 33' 15" AND 33° 49' 30" N. LATITUDE
75° 27' 12" & 81° 42' 30" W. LONGITUDE
FROM GREENWICH.

Wilmington and Weldon Railroad from Halifax to Goldsboro, thence southwest in a line parallel with the coast and about sixty-five miles therefrom, terminating at a point west of Lumberton. Marl is abundant and has been more or less utilized in twenty of the counties represented in this area, and beds have been located and samples analyzed from about fifteen other counties, but the outcrops are not as extensive and useful. By referring to the tables a fair idea can be obtained of the localities in which the deposits are most extensive and their products most generally utilized.

VARIETIES.

There are several varieties of marl in these deposits, the principal of which are Triassic, Cretaceous, Eocene, and Neocene—so called from the geological formation in which they occur.

Triassic.—Includes deposits in Wake County and southwestward. They are limited in extent and are not much used.

Cretaceous.—Includes the green sand formation, and occurs in the southeastern part of the State between Cape Fear and Neuse rivers, and is of the same formation as the celebrated green sand of New Jersey, but not as valuable because having a smaller percentage of green sand owing to the large admixture of foreign material. In New Jersey the average percentage of green sand is from fifty to ninety, while that of North Carolina is only from five to ten per cent. The outcrop is also comparatively small, so that for agricultural purposes the other varieties are of more practical importance.

Eocene.—This marl occurs in about the same locality and is found overlying the green sand. It is readily distinguished from the other by its outward appearance. The color is white or else a light drab or cream color, and where examined the fragments of shells or other organic remains are quite noticeable. The percentage of carbonate of lime in this marl varies from 40 to 90 per cent.

Neocene or *Shell Marl.*—This is much more abundant and more widely distributed than either of those previously mentioned. It is found in more or less abundance in nearly all of the eastern counties of the State, and is readily distinguished from the other varieties in that it is largely composed of undecomposed shells. The composition is very variable, containing on the average a less percentage of carbonate of lime than Eocene on account of the greater admixture of impurities. Some samples contain as high as 90 per cent. of sand, while others do not contain more than 10 to 25 per cent.

USES.

Marl forms a very valuable addition to our list of natural fertilizers. While its fertilizing value is increased very largely by the percentage of phosphate of lime or potash, its chief constituent is carbonate of lime, which gives to it its main value. Lime, when applied to the soil, affects it in different ways, and in its use there are several

points to be considered. It may be regarded somewhat as a direct plant food, as well as a chemical agent acting upon the organic matter of the soil and the various other mineral constituents of which the soil is composed. Another very important property which lime possesses is its mechanical action upon the soil. If applied to a light, sandy land it makes it less porous and less inclined to part with its moisture. On the other hand, if applied to a wet, clayey soil it tends to make it more porous and more easily worked. Notwithstanding the fact that large quantities of lime are consumed in plant life, it is not usually regarded as a fertilizer to be added to the soil, for the reason that the soil is usually abundantly supplied with it. It, however, has the power of decomposing the compounds of potash and soda from their insoluble combinations, both of which substances are of primary importance in the growth of the plant. Lime also decomposes organic matter in the soil and renders it available for the use of the plant. Lands which are very rich in vegetable matter have a tendency at certain times to produce organic acids in large quantities, forming what are commonly termed sour lands. Lime applied to such lands not only corrects the acidity but liberates a large amount of valuable plant food.

The term *lime* is usually applied to the caustic or burnt lime. Marl or limestone contains carbonate of lime, which can easily be changed to the caustic state by burning, but for agricultural purposes it may not always be remunerative or desirable. It takes much labor and expense to burn large quantities of marl, and where it can be made to serve its purpose it is desirable to apply it without burning. In many respects the two forms may be said to accomplish the same results, but not to the same degree of usefulness on different classes of soil. Generally speaking, caustic or burnt lime is the best for heavy clay soils and those rich in organic matter, while carbonate of lime does better for light soils and those containing little organic matter. From what has been said regarding the strong action of lime on the soil, it will be seen that considerable care must be exercised in its use. If too much is used it will cause a deterioration of the land, and is worse than nothing; and it will also be observed that soils rich in organic matter will require more than those destitute of the same. No definite rule can be laid down as to the amount to use, owing both to the great variety of soils and the variable composition of the material in question. The ordinary way among those who use it, is to apply from 100 to 200 bushels to the acre, but of course this can only serve as a guide in a general way, for the quality of the marl is so variable. One application is sufficient for several years. Besides the uses already spoken of, marl forms a very valuable material for composting, and the manufacture of some home-made fertilizers.

Phosphates.

Phosphoric acid combines in nature with several different bases, but the most common combination of this kind, as well as the

most valuable for agricultural purposes, is the tricalcium phosphate ($Ca_3 P_2 O_8$), or what is commonly known as phosphate of lime. Deposits of this material of more or less commercial value and importance have been located and worked in Virginia, North Carolina, South Carolina, Alabama, Georgia, Tennessee, and Florida, and it is probable that there are other beds not yet discovered. If no further discoveries should take place for years to come, the vast beds of South Carolina and Florida are capable of supplying the needs of the world far into the future.

Coprolites have been known for many years to occur in the marl deposits of the East and in the Triassic regions in Rockingham, Stokes, Chatham, and Moore Counties, but it was not known that phosphates existed in sufficient quantities to be of agricultural value until the deposits at Castle Hayne were discovered in 1883 through the means of this Station, after which time a small sum was appropriated by the North Carolina Department of Agriculture to be expended under the direction of the Experiment Station for the purpose of having a thorough survey made of the various phosphate localities. Explorations were accordingly conducted during the year 1884, at which time a large number of beds were examined and samples analyzed. Since that year the Experiment Station has assisted land owners who were interested in the development of these natural resources upon their property. A large number of analyses of samples representing different localities have accordingly been made, the results of which are incorporated in the annexed tables.

DISTRIBUTION.

The most important phosphate deposits in North Carolina, as has just been referred to, thus far investigated, lie in a belt fifteen to twenty miles wide, extending from the South Carolina line northeastward with the trend of the coast to the Neuse river It runs through the counties of Columbus, Bladen, Sampson, Duplin, and includes a small part of Pender, Lenoir, Jones, and Onslow. A conglomerate of phosphatic nodules and marl, less rich in phosphate than the preceding, lies just below this and extends southward through Pender and New Hanover Counties nearly to the coast. These nodules differ very much in size, and vary in color from a light gray to a greenish black.

The following extracts are taken from the report for 1885 of this Station, and give a good resumé of the occurrence of phosphates in North Carolina:

"The following resumé of the report referred to was made by Dr. David T. Day, for the Report of the United States Geological Survey on the Mineral Resources of the United States, 1883 and 1884. It will be useful as an epitome of our work and as the estimate of an outside expert upon the industrial value of our North Carolina phosphates:

"'Within the years which this report is intended to cover (1883

and 1884) discovery has been made of beds of phosphate rock in North Carolina of such extent that they must inevitably become an important factor in the phosphate industry of the United States. The discovery is due to Dr. Charles W. Dabney, Jr., Director of the Agricultural Experiment Station of North Carolina, and it is from the reports of this institution that the following account has been condensed. The beds of marl common in Virginia are also found in many counties of North Carolina. It has been known for many years that corpolites and fish teeth may be found at the bottom of this marl. They are mixed with shells and rounded pebbles of quartz. They have been noticed occasionally in such quantity that suggestions have been made in several geological reports as to their practical value for fertilizers, but they have remained untouched until now, although the associated marl has been dug for manuring adjacent land. This was the state of knowledge in regard to them from 1852 to 1883. In the winter of 1883 Dr. T. D. Hogg took a phosphatic specimen to the Experiment Station at Raleigh for examination. The specimen came from a farm at Castle Hayne, New Hanover County. It was followed by another specimen from the same county, near Rocky Point. Both consisted of a conglomerate in which phosphatic nodules, sharks' teeth, shells, etc., were bound together by a cement of carbonate of lime. Soon after this, Mr. Levi Moore and Col A. M. Faison sent samples from another part of the State, Sampson County, which bore more the character of phosphate rock. Brief explorations of these localities were made and so much interest was awakened that many samples were sent to the Station for analysis. The results showed that numerous deposits of phosphate rock exist in Sampson, Duplin, and Onslow Counties. This information was obtained in the first year after the earliest intimation had been received of the existence of the phosphate rock. In January, 1884, a surveying party was sent out, and the following account of its operations gives the basis upon which the subsequent opinion as to the practical value of the North Carolina phosphates is based. The phosphate localities lie in a belt fifteen to twenty miles wide, extending from the South Carolina line northeastward with the trend of the coast to the Neuse river, and with its southeastern boundary twenty to twenty-five miles from the coast line. It runs through the counties of Columbus, Bladen, Sampson, a corner of Pender, through Duplin, and includes a small part of Lenoir, Jones and Onslow Counties. It was the work of the first survey party to establish these limits by examining all the deposits and forming a crude estimate of the situation of each bed as well as the quality and quantity of phosphate. Phosphates were found in 148 localities in the whole belt. Up to October, 1884, seventy-one of these, lying in the central part of the belt, mainly in Sampson and Duplin Counties, had been explored. The boundaries of each bed were determined by digging pits at short intervals. The thickness of the beds and the distance from the surface were measured, and the yield of

rock compared with the amount of earth which must be removed to get to it. This exploration developed the fact that the belt is a gently undulating country sixty to 120 feet above the sea level. The beds are of very irregular outline and in what are usually termed 'pockets.' They are found on small streams, usually a few hundred feet down the stream from the marl beds. They lie in the bottoms and extend into the adjoining slopes. They are found at all depths from the surface to twenty feet, which is as deep as the exploration has been pushed. The surface soil is a very sandy loam, the subsoil a stiff yellowish or reddish clay. The phosphate rock is found frequently immediately underneath a stratum of two to four feet of this clay imbedded in coarse sand. Underneath this is another stiff, fine-grained, bluish clay. The layer of phosphate rock is six to twenty inches thick. The rock is in the form of light gray to dark greenish-black lumps, which are rounded and perforated, though less so than the South Carolina rock. They vary in size from that of an orange to great slabs or cakes weighing half a ton. The seventy-one beds explored lie along the line of the Wilmington and Weldon Railroad, on either side in an area seven miles square, including Warsaw, Bowden's station, and Faison's. Fifty of the beds, varying in size from one-third acre to twelve acres, were found to yield phosphate rock containing from thirty to sixty per cent. bone phosphate, and when followed only to a depth of ten feet yielded 100 to 1,100 tons per acre, the average being 407 tons to the acre. As this gives the average of the total area explored it does not represent the best yield which would be obtained in mining by neglecting poor beds. The following is a summary of the survey's work:

SUMMARY OF EXPLORATIONS OF NORTH CAROLINA PHOSPHATE DEPOSITS.

Total number of acres explored	124.98
Total number of pits dug	790
Total cubic feet earth excavated	69,719
Total pounds phosphate rock excavated	75,495
Total calculated number tons of phosphate rock in the 124.98 acres	50,864.48
Average tons per acre	406.98

"'In order to test the actual cost of mining the rock, a bed was selected not for its richness but proximity to the railroad, and the cost involved in loading fifty tons of rock on the cars was carefully noted, as follows:

COST OF MINING FIFTY TONS OF NORTH CAROLINA PHOSPHATE ROCK.

Cubic yards earth, etc., excavated	681.
Fraction of an acre excavated	0 11
Cost of excavation	$110.05
Cost of hauling	33.75
Cost of loading on cars	2.75
Cost of ditching	18.75
Total cost	165.30

"'This experimental mining was carried on during very wet weather in March, and it is probable that the expense could be

reduced to $110 instead of $165. The following are analyses selected at random from among a large number published by the Agricultural Station:

ANALYSES OF NORTH CAROLINA PHOSPHATE ROCK.

LOCALITY.	Moisture.	Sand and insoluble matter.	Carbonate of lime.	Phosphate of lime.
	Per Cent.	*Per Cent.*	*Per Cent.*	*Per Cent.*
Farm of J. W. Best, near Warsaw, Duplin County	1.08	42.96	4.18	42.46
Farm of D. I. Woodward, near Warsaw, Duplin County	.66	30.44	6.30	53.03
Farm of D. I. Woodward, near Warsaw, Duplin County	.39	36.59	6.30	45.78
Farm of R. Middleton, 2 miles east of Warsaw, Duplin County	1.57	38.09	3.81	45.16
Farm of R. Middleton, 2 miles east of Warsaw, Duplin County	.92	28 92	2.43	57.18
Farm of G. Middleton, 2 miles east of Warsaw, Duplin County	1.73	59.47	3.12	28.19
Farm of G. Middleton, 2 miles east of Warsaw, Duplin County	1.79	51.17	5.91	37.28
Farm of Levi Moore, 4½ miles south east of Warsaw, Duplin County	.63	37.36	4.96	44.51
Farm of Mrs. R. Bowden, 1½ miles west of Warsaw, Sampson County	.....	60.58	3.43	28.88
Farm of Col. A. M. Faison, 2½ miles west of Warsaw, Sampson County	.....	39.60	3 01	46.56
Farm of A. Rich, 3 miles south of Faison's, Sampson County	.....	34.60	5.71	46.19
Capt. L. T. Hicks, 4 miles southwest of Faison's, Sampson County	.....	35.76	5.11	43.53

"'These analyses show that the composition varies within considerable limits, but also that beds can be picked out which will yield phosphates as rich as those of South Carolina. They contain small amounts of calcium fluoride, oxides of iron, and alumina.

"'As to the chance of this rock being utilized, there is nothing in the location of the beds which would interfere with its being mined for local use in the manufacture of superphosphates. The beds are all comparatively near the Wilmington and Weldon Railroad, and the test of the cost of mining has shown that rock can be put on the cars at a price low enough for the profitable manufacture of superphosphates. Considering the enormous amount of manufactured phosphates used in North Carolina, it is safe to predict that factories will soon be established to satisfy the needs of the State by home products. At present phosphates are not manufactured to any great extent in North Carolina, except at the works of the Navassa Guano Company, near Wilmington. This company is so removed from the phosphate region, and has become so well connected with other sources of phosphate rock, that it must be looked upon rather as a foreign element, and if the new beds are to be utilized it must be by

manufacturers located nearer the deposits and working in common with the miners. Such home manufacture will have the advantage of minimum freights for crude material as well as manufactured fertilizers. In regard to the possible influence of the North Carolina phosphates upon the fertilizer trade at large, it must be remembered that the question of exportation brings up the sharpest competition with the Charleston phosphates. If phosphates can be shipped from North Carolina which contain as much calcium phosphate as those of South Carolina, the competition comes upon an even footing, and that phosphate will find sale which can be delivered at least cost. The superior facilities for loading on vessels at Charleston would probably be sufficient to decide in favor of those deposits, which are directly at a deep-water harbor, while the North Carolina phosphates must be mined through woods and swamp land, requiring much improvement in the way of terminal facilities. Further, in order to compete with the South Carolina industry, North Carolina must break into well-established lines of trade involving other industries than phosphates. It has still to be shown that the phosphate deposits of North Carolina are so extensive as to become a rival of Charleston in point of quantity. If, however, they should prove equally large, the question of their utilization outside of the State is one of the time when the cost of mining in Charleston shall rise to the limit of profitable shipment in North Carolina.

"'The 'conglomerate' found near Castle Hayne and Rocky Point, in New Hanover County, is a formation different from phosphate rock. It is found at the bottom of marl beds, and consists of cemented coprolites and bones of fish. Taken as a whole, the composition of the conglomerate is given in the following analysis:

ANALYSIS OF NORTH CAROLINA COPROLITIC MARL.

	Per Cent.
Calcium carbonate	64.26
Calcium phosphate (bone phosphate)	11.16
Magnesia	.81
Potash	.40
Sulphates and chlorides	Traces.
Sand, soluble silica, oxide of iron, alumina, etc., undetermined	23.37
	100.00

"'The conglomerate is found in large beds along the northeast Cape Fear river, in Pender and New Hanover Counties. The beds are seen wherever the creeks have cut through the sand or wherever ditches have been dug, throughout a region twenty-five miles long and ten miles wide. Beginning at the south, they appear at various points about Wilmington; one mile east, at a ballast quarry, whence a lean phosphatic rock has been shipped to many parts of the world as ballast; two miles northeast, along the banks of Smith's creek; one and a half miles east, in S. W. Noble's marl pits. From this point the beds extend up the northeast Cape Fear, appearing chiefly upon the right bank of the river, and throughout the country to the east, until they disappear under the sand banks of the coast. Ten

miles north of Wilmington, in the Castle Hayne neighborhood, they attain their greatest development and come nearer the surface. They appear all along the bank of the creek here four or five feet thick, and in the fields adjoining the creek the conglomerate is found within two feet of the surface and four to five feet thick. The beds cross the river one and a half miles north of Castle Hayne, and from this point onward appear chiefly on the west side, between the river and the line of the Wilmington and Weldon Railroad. Here again they are seen on the banks of the creek and in the ditches. They are exposed to great advantage on the French Brothers' farm, three miles east of Rocky Point, where marl and limestone have been largely dug. The Messrs. French have removed the limestone for burning lime down to the conglomerate and exposed it for several acres. To the north from this point the beds are found on Durham farm, the Walker farm, across the river on Gregory's creek, etc., until they are lost in Holly Shelter and Angola Bay swamps. North of the swamps, in Duplin, Onslow and Jones Counties, the phosphates occur again [but now as phosphate rock].

"'At French's bed a tough, solid shell-limestone five to seven feet thick is found three or four feet below the surface; below this the conglomerate is two inches to two feet thick. At Castle Hayne there is either a mere skim of the limestone or none at all, covering the four to five feet of conglomerate. At the other places a layer of loose nodules is found on top of the conglomerate. At Noble's farm, near Wilmington, a bed of very soft marl two feet thick is found carrying the nodules, and a bed of hard conglomerate under this for two feet deeper. At other places, a thick bed of shell marl rests upon the conglomerate. The nodules of this conglomerate are of all sizes from a pumpkin to a bean. They are smaller about Wilmington and Castle Hayne, and larger at French's. They are of all shapes, but for the most part kidney and egg shaped. Their color is light gray to greenish black. Some are perforated, but less so than South Carolina rock. The composition varies markedly even in the same piece of conglomerate. The following is the complete analysis of one of the nodules from the conglomerate, taken at random:

ANALYSIS OF PHOSPHATIC NODULES FROM CONGLOMERATE.

	Per Cent.
Sand	43.66
Carbonate of lime	34.56
Magnesia	.86
Potash	.39
Oxide of iron and alumina	.56
Phosphate of lime	19.99
Sulphuric acid	Trace.
Chlorine	Trace.
	100.02

"'The variations in composition of the nodules from different localities, and even from the same locality, are illustrated by the following analyses:

COMPARATIVE ANALYSES OF PHOSPHATIC NODULES FROM CONGLOMERATE.

		Sand and insoluble matter.	Carbonate of lime.	Phosphate of lime.
		Per Cent.	*Per Cent.*	*Per Cent.*
From Castle Hayne	1	22.07	42.12	20.50
	2	33.52	20.45	33.97
	3	----------	----------	30.90
From French's farm	1	18.56	39.04	25.34
	2	20.02	42.12	22.68
From Noble's farm	1	3.25	51.34	31.59
	2	31.66	15.94	42.09

"'The average percentage of phosphate of lime in a large number of these individual nodules, separately examined, is 32. A large lot of nodules ground up together and well mixed gave 30.90 per cent. phosphate of lime. The economic relations and agricultural value of these deposits were tested this year (1884) with such good results that a company, called the North Carolina Phosphate Company, has been formed to put this material on the market. The conglomerate is very easily mined. After the two feet of earth is removed with plows and scrapers, the deposit is shattered with powder, crushed and ground. The deposits are on navigable water, and will probably be profitable.'"

Castle Hayne Deposit.—The following preliminary report on the phosphatic deposits of Pender and New Hanover Counties, which was published by Dr. H. B. Battle in the annual report of the Experiment Station for the year 1888, is here inserted as a matter of interest, showing as it does the relative proportion and quality of each stratum of the deposits examined:

"The phosphatic deposits of eastern North Carolina in the counties of Pender and New Hanover have been worked continuously during 1888 and '89, up to the period at which this report is printed, and the products have been extensively shipped and used throughout the State.

"The examination of the present status of the beds is now going on. This preliminary report will, however, only treat of the beds mined on the Castle Hayne property in New Hanover County, owned by the North Carolina Phosphate Company. These beds are located nine miles north of Wilmington, N. C., on the north side of Prince George's creek, following this creek westwardly to its junction with the North East river.

"*Bed A.* The locality of that portion of the deposit now most extensively mined is in extent, so far as known at present, about 40 acres, and lies at the eastern limit of the Castle Hayne deposit. This mine has been worked in extent averaging 350 feet by 150 feet, and 15 feet deep, though a depth of 20 feet has been reached at some points.

"From bed A has all the merchantable phosphatic conglomerate

(when ground known as 'lime phosphate') been taken, as well as the more rich phosphatic nodules at a lower depth of a later discovery. The merchantable phosphatic materials including the 'lime phosphate' and the various nodules of different grades, rich in phosphoric acid, mined for the year ending May 1st, 1889, amounted to 2,000 tons.*

"An ideal section (stated below) of this mine would give the relative proportion and quality of each stratum. These strata are for the most part horizontal, showing deposition. No. 1, which represents the top stratum, is sand averaging 3 feet in thickness. Next follows 18 inches of clay (No. 2), underlaid by 6 inches of peat (3). No. 4 is a limestone rock from 8 to 16 inches thick, running 95 per cent. carbonate of lime. Next (5) is the conglomerate furnishing the merchantable 'lime phosphate,' composed of phosphatic nodules cemented solidly by nearly pure carbonate of lime. This stratum is from 4 to 6 feet thick, averaging 5 feet. Under this phosphatic conglomerate is a layer (6) of loose nodules, running from $2\frac{1}{2}$ to 4 feet thick, with an average thickness of $3\frac{1}{2}$ feet. This layer contains a small amount of loose sand. The layer (7) immediately underneath averages only 4 inches in thickness, ranging from 3 to 5 inches. This bed is composed of smaller phosphatic nodules than is found in No. 6. Next is (No. 8) a bed of loose nodules and lime, containing very little sand, and is 18 inches thick. In practice it is found convenient to raise these strata together, and consequently after mining they are more or less mixed. No. 9 averages 12 inches thick, and contains nodules of somewhat poorer quality mixed with disintegrated lime rock and a small quantity of sand. Beneath this stratum are found pockets of solid phosphate rock, resembling very closely the phosphate rocks of Duplin County. Analysis shows this rock to contain a large percentage of sand. These pockets vary from 3 to 6 inches in thickness. Lastly, below 10, is found a solid shell rock (11) containing 95 per cent. of carbonate of lime and of unknown thickness. This stratum is extremely hard and only a depth of 18 inches has been reached. Owing to its toughness a dynamite cartridge exploded in it can only fracture a short distance from the drill hole. At a depth of 18 inches there appears to be no indication of any different substratum.

*The mine is now (1894) equipped for the shipment of 100 tons per day.

"Portions of the various strata have been analyzed at the Station with the following results:

ANALYSIS OF STRATA IN BED A.

	STRATA.	Moisture.	Sand.	Potash.	Carb. Lime.	Phos. Acid.	Equiv. to Phos. Lime.
No. 4.	Lime Rock	------	------	------	95.00	------	------
" 5.	Hard conglomerate	------	------	.40	64.26	5.10	11.16
" 6.	a. Sand and fine phosphatic nodules	------	------	.15	13.01	4.70	10.25
	b. Phosphatic nodules, medium size	------	------	------	8.44	19.77	43.17
	c. Phosphatic nodules, larger size	------	------	------	8.76	17.03	37.19
" 9.	Phosphatic nodules excluding lime rock	1.30	29.00	------	7.98	20.35	44.45
" 10.	Solid phosphate in pockets	.45	46.25	------	35.60	5.73	12.52
" 11.	Shell rock	------	------	------	95.00	------	------

"Through the courtesy of C. M. Hawkins, president of the company, below is given a complete analysis of the stratum No. 6:

Moisture	1.75
Loss on ignition	4.30
Lime	27.80
Magnesia	.22
Oxide of iron and alumina	6.37
Potash	1.15
Soda	1.28
Phosphoric acid	17.27
Carbonic acid	4.00
Sulphuric acid	1.46
Silica and sand	34.40
Total	100.00

"*Bed B.* The portion of the deposit at Castle Hayne, to be called in this preliminary report "Bed B," has never been heretofore described, and has only been discovered but a short while. It is situated about 800 feet west of Bed A, and extends, as has been determined up to this time by actual pits dug, 500 yards down Prince's creek and in breadth 100 yards. It is probable that this bed extends southward across the creek. The strata are so nearly alike throughout this area that an ideal section will nearly represent the whole area. This bed is as yet not mined for merchantable purposes.

"The strata are horizontal as in Bed A, but different from the latter in the order of deposition. In Bed B the phosphatic conglomerate (No. 5) of Bed A is wholly wanting, as well as the phosphatic nodules of Nos. 7, 8 and 9, leaving only a small portion of the phos-

phate of lime existing in Bed B, much smaller indeed than is seen in Bed A.

"An ideal section of this bed will represent an average of 3 feet of sand at the surface, followed by 2 feet of clay, which is underlaid by 6 inches of peat (3). So far this section is nearly identical with the section of Bed A. But instead of having now the hard conglomerate of the latter bed there is a stratum of 4 feet on the average of phosphatic nodules intermingled with dry clay and free from sand. Finally is seen the hard shell rock (5) extending to an unknown depth.

ANALYSIS OF STRATUM 4 OF BED B.

	Moisture.	Potash.	Phos. Acid.	Equiv. to Phos. Lime.
Stratum 4, loose nodules alone	1.88	1.05	13.04	28.47

USES.

It is hardly necessary at the present day to dwell on the importance of finding means of restoring to the soils the chief elements annually taken away from them by the crops. The elements which play the most important parts in the functions of vegetation, and those which are the most liable to exhaustion in the soil, have been found to be nitrogen, phosphoric acid, and potash. Of these three important factors of plant life, phosphoric acid is by no means the least important; the quantity annually removed from the land in the United States by the cereals alone approximates the enormous amount of 2,714,595,473 pounds. The yearly cropping of the land has so reduced the available supply of phosphoric acid that the importance of an artificial supply is generally recognized, and the world's consumption of mineral phosphates and superphosphates from all sources amounts to several million tons yearly. The commercial supply in the United States is largely obtained from South Carolina and Florida; but for home consumption the North Carolina phosphates are beginning to be considerably used and might be more extensively utilized, especially in the vicinity of the deposits. The real value of these natural products for fertilizing purposes depends for the most part upon the percentage of phosphoric acid, which can only be determined by chemical analysis.

In addition to the value as established by chemical composition, there are several other items to be considered in utilizing this raw material, either as a commercial article or for home consumption, *i. e.*, the cost of mining, grinding, hauling, etc.

Before the phosphate rock can be really considered as a fertilizer it must be finely pulverized, so that the action of the various chemical agencies of the soil can make it more easily available as plant food.

Even in this form the phosphoric acid is very slowly dissolved and little commercial value is attached to it, yet if it can be obtained at small cost it will prove a very valuable addition to the fertilizer supply. The soluble form, or the acid phosphate of the trade, is made by treating this ground rock with sulphuric acid, which, having a greater affinity for the lime, combines with it to form calcium sulphate, and thus partially liberating the phosphoric acid and leaving it combined with a smaller proportion of lime, which combination is easily soluble. In this form the phosphoric acid is nearly all made available and is readily taken up by the plant. For convenience the products of these deposits can be divided into two classes: those which contain sufficient phosphoric acid for the profitable manufacture of acid phosphate for commercial use, and the lower grades which can only be profitably used in the vicinity of the production. The manufacture of North Carolina acid phosphate is now being carried on to a considerable extent compared with former years. It has been found that an article containing from 10 to 13 per cent. available phosphoric acid can be made at comparatively small cost. While the rock is not quite as high grade as that from South Carolina, it grinds readily and takes about one-third less acid, thus reducing the cost of manufacture, at the same time retaining a good percentage of phosphoric acid.

The rock thus far examined works well with acid, the reaction takes place very promptly and completely, and the mass is left in a very porous condition and therefore dries out rapidly.

The lower grades of rock and the marls containing phosphoric acid, while they cannot be profitably used in the manufacture of acid phosphate, will prove valuable for home use. The small cost at which they can be procured will doubtless make it profitable to ship them a considerable distance. They can be ground at a small cost and when applied to the land, while the fertilizing effect will be slow, the beneficial results will be noticed for a number of years. Especially is this true if they are previously composted with such organic matter as stable manure which in fermenting has a tendency to slowly decompose the insoluble phosphate of lime.

The virgin fertility of the soil of American farms is fast being exhausted, and the successful farmer is the one who takes advantage of every opportunity. In the line of fertilizers he must learn to utilize all waste products, and if there is an available natural supply at hand he will make use of it. It is hoped by calling attention to these deposits of marls and phosphates that they may be more extensively and profitably used.

DEPOSITS OF MARLS AND PHOSPHATES IN NORTH CAROLINA.

On the following pages will be found descriptions of deposits, together with tables giving analyses of some of the principal marls and phosphates which have, from the establishment of the Station in 1877 to the present, been sent to it, or collected through special surveys for examination. These results may be said to fairly represent the character of the different formations in the State thus far examined. Preceding the tables of analyses can be found such available information concerning the location, ownership, extent, and character of each deposit from which the samples were taken as would be of value in the selection and use of the material for economic purposes. The descriptions of a large portion of the phosphate beds is taken from the very complete reports of Gen. W. G. Lewis, Engineer of the Phosphate Survey conducted by the Station in 1884; while the information concerning the marl beds was taken largely from descriptions of the deposits written by the owners at the time the samples were sent. For convenience of reference the different analyses have been arranged by counties, giving in each case the name and address of the sender or owner. It is likely, however, that in many instances the properties have changed hands and the addresses of the senders will not be the same as when the analyses were made.

Description of Deposits of Marls and Phosphates.

BEAUFORT COUNTY.

3287. White shell marl, and 3288, rock containing a little marl, from the farm of Col. R. W. Wharton, of Washington. The bed is 3 feet below the surface, 3 feet thick and covers about an acre. It is located 4½ miles west of Washington.

3347. Marl sent by Col. W. A. Blount, of Chocowinity, who writes, "The bed is located on Hill's creek, about one mile from its mouth. The creek empties into Pamlico river, about six miles below the town of Washington. The specimen sent came from the side of a hill, the earth having been removed from it years ago to the depth of 6 feet. The bed of rock extends into the low grounds of the creek, and crops out on the opposite side, apparently a large deposit."

4482. Sand marl from F. S. Stickney, Yeatesville, who writes: "My farm is a clearing of 200 acres in Laurel swamp, on the north side of Pamlico river, in the eastern part of the county. All this section, bordering as it does on the Great Dismal, is a high land alluvion, beneath which there is a 3-foot strata of marl of a similar quality to the sample I send to-day."

4524. Marl sent by C. F. Warren, Washington. "Came from Mr. Sharendon's farm in this county. It is one mile east of the village of Yeatesville. The bed covers an area, as far as developed, of 30 or 40 acres. It has been tried on lands that were perfectly dead, and in consequence it produced fine crops of corn and cotton without the use of other fertilizers. This marl is found at a depth of 16 inches from the surface, and has been dug to the depth of 9 feet. How much

deeper the bed goes has not been ascertained, in consequence of the water. Is found in lumps from the size shown up to size of fist. It is found about 18 inches from the surface of the earth."

4525. Marl sent by C. F. Warren, Washington. "Came from same bed as that of No 4524. Underlies it and is found in a solid bed. This strata is about 18 inches thick."

4526. Marl sent by C. F. Warren, Washington. "Came from same bed as Nos. 4524 and 4525. It underlies No. 4525 and is in a mass of shells 3½ feet through, and is mixed with earthy substance as in sample. The shells are in a much larger proportion."

BERTIE COUNTY.

2567 and 2568. Marls from the farm of Dr. H. V. Dunston, Windsor. Found near Cashie river.

3963. Blue marl from Eden House, near mouth of Chowan river. Bed 4 feet thick and half mile long. Sent by D. Bell, Avoca.

3964. Yellow marl from same bed as No. 3963, top layer.

4903 and 4968. Marls from Hon. Francis D. Winston, Windsor.

6481. Marl from the land of Edward Bazemore, Lewiston, Snake Bite township. The deposit is about 200 yards square and is found on the banks of a small stream flowing into Wattauna swamp.

7550 and 7551. Marls from Dr. W. R. Capehart, Avoca.

8261–62. Grey and yellow marls, from T. B. Davis, Windsor. Samples sent through Hon. F. D. Winston, Windsor.

BLADEN COUNTY.

35. Marl from J. G. Blue, Elizabethtown.

2856–57. White shell limestone sent by R. H. Lyon, Elizabethtown, taken from the same bed, from a strata 3 and 4 feet thick and 25 yards in length, width unknown.

2858. Taken from the same farm, but from a different locality.

2905. Phosphatic marl from the farm of D. A. Lamont, Brinkland. The marl is found in considerable quantities in a flat country 1¼ miles from the river. Supposed to be phosphate and on this account only phosphoric acid was determined.

3150–51. Marls from W. J. Sutton, Little Sugar Loaf. Found in large quantities from 1 to 5 feet below the surface on Hammond creek and Broad branch, about 50 miles from Wilmington, on the west side of Cape Fear river.

3742. Marl from Dr. J. S. Devane, Brinkland. From "the west bank of the Cape Fear river, forming part of the river bank. It forms a continuous bed from Wilmington to White Hall, a distance of 60 or more miles. It crops out at Waccamaw Lake (14 miles), and at Brinkland has been cut through in digging a well. The darker marl is from 3 to 5 feet thick, resting on the main bed, and is softer than the marl under it. Applied it several years ago to a piece of land very poor and destitute of vegetable matter; the crop (corn) grew off well, but when the weather got warm in June it turned yellow and died. This was corrected by the addition of vegetable matter. The marl contains, also, coprolites (No. 3943). On clay soil one application of 600 to 1000 pounds has never failed to increase the product from 300 to 500 fold," etc.

3794. Marl from Dr. J. S. Devane, Brinkland. Upper formation.

4607. Lime rock from L. J. Hall, Elizabethtown, who writes: "Taken from my farm, 10 miles below this place, on the Cape Fear river. Do not think it a fair sample, as it was taken from the edge of the rock."

5618. Marl from lands of E. N. Robeson, Tar Heel. A large deposit, extending over considerable area. Is mixed with coprolites and small bones.

6173–75. Marls from K. J. Braddy, Westbrook. No. 6173 is of a dark color and overlays Nos. 6374 and 6375, which are of a yellow color.

6389. Marl from land of Mrs. Ellen P. Guion, Lyon's Landing.

6390. Phosphate rock taken from same bed as 6389. "On river bank near by small pieces of phosphate are found on the surface." Sent by Gen. W. G. Lewis, Goldsboro.

6510–12. Marls from E. N. Robeson, Tar Heel. "Taken from well when putting down sawmill."

6511. Fossilized bone from same locality as 6510.

2759. Phosphate from Black Rock, on Cape Fear river, about 15 feet below surface, immediately overlying a heavy deposit of blue marl rock cropping out. Stratum about 5 inches. There is here a stratum of rock said to be 4 feet thick, lying immediately under this marl, and projecting 15 to 20 feet into the river. Owing to high water it was impossible to inspect it or obtain a sample.

2906 and 2907. Coprolites from D. A. Lamont, Brinkland. Found on the west side of the Wilmington-Fayetteville road, and about 50 yards from the same on a branch. The bed shows itself again about half a mile off.

3743. Coprolite from J. S. Devane, Brinkland. Found in marl No. 3742. These are numerous in the marl at Indian Wells Landing.

BRUNSWICK COUNTY.

3275. Marl sent by Henry Addix of New Supply, who writes: "The marl bed is the property of Mr. Sylvester Dixon, and located on the western side of Lockwood's Folly river, about 3 miles from the inlet, under a high bluff of clay and sand. The east side of the bed for about 40 yards is washed by the waters of the river and the abrasion shows plainly the upper stratum of the bed. A strip below is of about an average depth of 10 feet from the water at low tide and of seemingly pure marl of more than 10 feet depth, quite like the shingle of the beach, runs the whole length of the bed on the river side, and is of easy excavation. A well about 60 yards from the river and 25 feet deep has marl at the bottom, and therefore I assume the bed runs at least 60 yards or more, from the river inland. The minimum extent of the bed is 40x60 yards. The bluff covering of the bed is from 10 to 20 feet high, but the marl under it becomes forbidden fruit, as the excavation by ordinary means would be unprofitable. There is another bed farther up the river on the eastern shore, of seemingly excellent quality and more accessible."

CHOWAN COUNTY.

4297. Shell marl sent by Dr. J. M. Hayes, Barnitz. "There is an almost unlimited quantity of it on my place, having been deposited by a settlement of Indians in prehistoric times. The farmers in this locality speak very highly of its use, especially in low lands. It is deposited in a bank from 3 to 4 feet deep, covering a space of several acres, snd can be reached easily by vessels on the Chowan river. It forms part of the shore of the river in a few feet of a wharf. There is quite an intermixture of decaying Indian bones in the marl."

4485. Shell marl from same locality as No. 4297. Dr. Hayes thinks "there are at least 10,000 tons of the shells."

COLUMBUS COUNTY.

514–15. Marl sent by the Whiteville Wine Company, Whiteville. Taken from beds near Whiteville.

1615. Marl sent by Navassa Guano Company, Wilmington.

2198. Marl from the land of J. L. Manning, Peacock's Store.

2330–31. Marls from the property of Acme Manufacturing Company, Cronly.

3911. Marl from John Hinson, Chadbourn. Found on his land, 2 miles north of Grists and 2½ miles from Chadbourn, and on the edge of "Big Canady" branch about half a mile from its confluence with Dunn swamp. The blue marl is 4 feet below the surface and about 2 feet thick; then comes about a 3-foot stratum of shell marl. Bed is about half a mile long and 50 feet wide.

6547–48. Marls from the land of J. M. Shipman, near Whiteville. The deposit consists of a top layer of brown marl (No. 6547) which is mixed with blue clay. Beneath this layer is a stratum of white or shell marl (No. 6548).

8260. Marl from R. C. Applewhite, Cronly. Sent by M. Folly, Aberdeen.

8585. Marl sent by E. L. Applewhite, Applewhite.

2750. Small nodules from marl bed on farm of R. D. Sessions, 4½ miles northeast of Whiteville on the east side of a stream tributary to White marsh. Quantity seems large.

2754. Phosphate rock from same locality as last, 3 feet below surface. Stratum about 12 inches. Quantity good.

2649. Phosphate from farm of R. D. Sessions, near Whiteville. Said to be in large quantities and near the surface.

2752. Small phosphatic nodules found on bluff of marl on south shore of Lake Waccamaw. Quantity seems large. Sent by Gen. W. G. Lewis, Goldsboro, N, C.

3398. Phosphate rock from D. S. Cowan, Robeson.

CRAVEN COUNTY.

278. Limestone from R. A. Russel, Cobton.
428. Marl from John A. Jackson, Vanceboro.
506. Marl from Charles B. Stubbs, Vanceboro.
523. Earth from Henry Powel, Vanceboro. Mostly organic matter.
644. Marl from O. C. Nobles, Vanceboro.
721. Marl from a deposit about 2 miles from Newbern on the A. & N. C. R. R. Sent by George Allen, Newbern.
1119. Marl from Biddle place on Neuse river.
1139. Marl from George Green, Jr., near Newbern.
1297. Marl from near Newbern. Sent by George Allen & Co.
1952. Marl sent by Col. J. Y. Brice, Charlotte.
2153–54. Marls from a deposit on Bachelor's creek, near Newbern. No. 2153 is from the top stratum, which is about 18 inches thick. No. 2154 is from the second stratum, thickness unknown.
2155–57. Marls from the land of D. Reid, situated on Caswell branch near Newbern. The numbers represent respectively the first, second and third strata. Thickness unknown.
2855. Marl from farm of K. R. Jones, near Newbern. Found in large quantities near surface.
2859. Marl from farm of Mallet Bros., Riverdale. Found on river bank one foot below surface. Sent by George Allen, Newbern.
2860. Marl sent by George Allen, Newbern.
3241. Marl from land of Mr. Dillard or Dunlop, sent by J. Y. Bryce, Charlotte.
4504. Marl from N. A. Pursser, Vanceboro. "This marl bed, I know, underlies or underbeds about five or six acres of swamp land. The swamp is one of Swift creek's tributaries. It has been reached in many places of the bed with an auger. The marl has been penetrated at a depth of 2½ feet with an auger. Have not made a success digging, owing to the very wet condition of the land after it was found last fall. It lies from 6 to 8 feet under ground, and no sand to bother. It is from 1¾ to 2 miles from Vanceboro. The sample I sent I do not think is a fair sample, as it was obtained from near the surface of the bed."
3767. Marl from farm of L. J. Moore, near Newbern. Inexhaustible quantities.
4204. Marl from farm of P. Fenneth, some miles below Newbern.
4652. Marl from Gardner & Chapman, Maple Cypress.
6334. Marl from William B. Lane, Newbern.
6414. Marl from the farm of Watson & Daniels, near Newbern.
6506–08. Marls from the land of J. B. Gardner, Maple Cypress. Extensive beds.
6523–28. Marls from the farm of Watson & Daniels. From beds situated on Boyce's creek, near Trent river.
8253. Marl from the land of Andrew Jackson, located on Brown's branch near the Washington main road, and about 1½ miles from Vanceboro.
8349. Blue marl, calcined and ground. From the land of G. L. Hardison, Thurman.
8351. Black marl from C. C. Kirkman, Redallia, Pitt County, who writes: "There are 75 to 100 acres in Craven County." Sent by W. H. Worth, Raleigh.

CUMBERLAND COUNTY.

1116–17. Blue and shell marls from E. J. Fuller, Fayetteville,

DUPLIN COUNTY.

456–58. Marls from W. H. Williams, Warsaw.
972. Marl from R. J. Williams, Warsaw.
1127. Marl sent by Ward Taylor, Magnolia.
1183. Marl from J. R. Faison, Faison.
2120. Marl sent by Levi Moore, Warsaw.
2835. Marl from the farm of J. H. Maxwell.
2836. Marl from same locality as 2835, found on branch near land of G. M. Maxwell.
3197. Marl sent by E. J. Hill, Warsaw.
3865. White marl from a bed on Shaking creek, owned by Dr. Matt Moore, Warsaw.

4321, 4361-65. Marls from the farm of B. Witherington, about 14 miles from Mt. Olive. Designated respectively as Nos. 1, 2 and 3. No. 1 is from a very large bed, "extends for at least 1,000 yards down the creek." No. 2 is not as extensive as No. 1, but No. 3 is from a larger bed than either Nos. 1 or 2.

4373. Marl from W. B. Southerland, Rose Hill, who writes: "It is found 2 miles southeast of Rose Hill. It is found at a depth of 1½ to 3 feet under surface; do not know how deep it is; have never dug more than 4 feet down. There are 3 different kinds; first is a fine yellow, and at a distance looks like sulphate potash; the second is the sample which appears to be of fine bones; the third is shell marl. This marl bed is on a tributary of Island creek swamp, ¾ of a mile from the mouth of branch."

4424-25. Marls from land of Stephen Graham, Kenansville.

4165. Marl from land of W. L. Hill, Warsaw.

5246. Marl from A. W. Maxwell. Resaca.

5594-95. Marls from land of G. W. Lamb, located about 1½ miles below Chinquepin, on the east side of North East river. The coarse lump (No. 5595) was from the hard top layer, which is about 3 feet thick. Underneath this is found the fine marl (No. 5595), which has been dug to a depth of 10 feet.

5647. Marl from the land of W. B. Southerland, Rose Hill. "It is found 1 mile east of Rose Hill, in Island creek swamp, also 1 mile from its source. There are 60 or 75 acres of this marl belonging to several parties, but in one bed, from 2 to 6 feet from the surface."

6146-6166. Phosphatic marls from the land of Daniel Moore, located 3½ miles from Warsaw and ¼ mile from the Warsaw and Clinton Railroad. The bed is 2 to 3½ feet from the surface, 2½ feet thick, and has an area of ¼ to ½ acres.

6435. Marl from A. D. McGowan, Kenansville. The bed is on high lands covering 6 to 10 acres. The top layer is hard and about 2 feet thick; has been dug 25 feet underneath without going through.

6465. Marl from the land of Milton Southerland, near Wallace. The deposit is 3 to 4 feet below the surface and is 5 feet thick. It covers an area of about ½ an acre. No shells are found in the deposits.

6487. Marl sent by Milton Southerland, Wallace.

6493. Marl from Daniel Moore, Warsaw.

6644-45. Marls from Dr. D. McL. Graham, Wallace.

2263. Phosphate rock from Levi Moore, 3 miles southwest of Warsaw.

2334, 2336 and 2338. Phosphate rock from R. M. Middleton, 2 miles east of Warsaw.

2335. Phosphate rock from R. M. Middleton, 1½ miles northeast of Warsaw.

2337. Phosphate from land of G. W. Middleton, 1½ miles east of Warsaw.

2339. Phosphate rock from land of Col. A. M. Faison, 2 miles east of Warsaw.

2474. *a* and *b*. Phosphates from the land of J. W. Murray, Kenansville.

2490. Phosphate from land of J. W. Best, ¾ mile east of Warsaw.

2541. Phosphate from land of W. H. Kornegay, 3 miles south of Kenansville.

2580. Phosphate from land of J. W. Best, ¾ mile east of Warsaw.

2488. Phosphate from the farm of Daniel Bowden, ¾ mile east of Bowden's Station, W. and W. R. R., and about 4 miles north of Warsaw. Found below a bed of blue marl, 4 to 6 feet below the surface. Stratum 6 inches thick.

2489. Phosphate from the farm of Arthur Weeks, ¾ mile west of Bowden's. Picked up where his well was dug.

2490. Three specimens of phosphate from the farm of J. W. Best, ¾ mile east of Warsaw and a short distance south of the Warsaw-Kenansville road. Two and a half feet below the surface, a bed of marl underneath them. On several of the ditches and branches on his farm, and only a few feet below the surface. Stratum, where these were dug, 6 inches thick.

2491. Phosphate from the farm of Col. A. M. Faison. Said to be in large quantities.

2492. Phosphate from the farm of the heirs of Rufus Bowden, 1½ miles west of Warsaw. Specimen from a marl pit 7 feet below the surface. Stratum 6 inches. About 200 feet higher up the branch, and about 8 feet below the surface, the same rock is found.

2542. Phosphate from farm of G. W. Middleton, 3 miles east of Warsaw, on Kenansville road. Found in a ditch ¼ mile north of house and 3 feet below surface, and seems to be in large quantities and very accessible.

2543*A*. Phosphate from Grove branch, on farm of R. Middleton. Found 3 feet below the surface, and gives indications of large quantity.

2543*B*. Phosphate from fish pond branch on same farm, in large quantities.

2544. Phosphate from the farm of Jesse Swinson, 6 miles northeast of Warsaw, on the Warsaw-Faison road.

2545. Phosphate from the farm of J. A. Boyd, 1½ miles east of Warsaw, and between the two roads from Warsaw to Kenansville. Found in a ditch 2 feet below the surface, in large quantities, very accessible.

2546. Phosphate from the farm of Kilby Hollingsworth, 2 miles north of Magnolia, on Magnolia-Kenansville road. Found in a ditch 3 feet below the surface, on the top of a white shell marl, and gives indications of some quantity.

2547. Phosphate from farm of L. Middleton, 5 miles east of Warsaw, on the Warsaw-Kenansville road, 4 feet below the surface.

2548. Phosphate from the farm of A. Hollingsworth, 2 miles north of Magnolir, and 1½ miles from W. and W. R. R.

2549. Phosphate from the farm of Levi Moore, 4 miles east of Warsaw, on the Warsaw-Kenansville road. Ten feet below the surface and below marl.

2550. Coprolites from the farm of R. Middleton, in the Grove branch.

2551. Phosphate from farm of R. Middleton.

2552. Phosphate from farm of A. D. Johnson, 1½ miles southwest of Kenansville, on the old Newbern-Fayetteville road. Large quantities in the bottom of ditches and 3 feet below the surface, and in some places among marl. It is black.

2553. Phosphate from the farm of G. W. McLammy, 3 miles west of Kenansville, on the Kenansville-Magnolia road.

2554. A mixture of fragments of bone, coprolites and phosphate rock, from the farm of J. B. Carr, 5 miles north of Kenansville, on the road to Faison's depot.

2555. Coprolites from the farm of A. D. Johnson, 1½ miles southwest of Kenansville, on the old Newbern-Fayetteville road.

2556. Phosphate from the farm of Col. A. M. Faison, 2½ miles west of Warsaw on the plank road. Found 3 feet below surface and 250 yards from his dwelling. Stratum about 6 inches thick. Quantity seems large.

2560. Phosphate from a ditch which divides farms of J. N. Williams and A Blanchard, 4 miles west of Warsaw, in Duplin county, and southwest of Col. A. M. Faison's. Stratum 6 to 8 inches, and 3½ inches below surface.

2561. Phosphate found in ditch which divides farms of John Blanchard and Col. Faison, 3 feet below surface, in Duplin county. Stratum 8 inches.

2562. Phosphate found 3 feet below surface on lower edge of a hill 3 miles south of Warsaw, on east side of W. and W. R R., on farm of W. C. Carlton, in Duplin county. Stratum 6 to 8 inches.

2563. Phosphate found 2½ feet below surface, on the farm of W. H. Windows, 2½ miles east of Warsaw, on the Magnolia road, and on east side of W. and W. R. R. in Duplin county. Stratum 10 inches.

2564. Phosphate found in a pit of blue marl 4 feet below surface, on same farm. Stratum 6 to 8 inches.

2565. Phosphate found on the surface of the side of a hill on the same farm.

2566 Phosphate from the farm of W. H. Windows, 2½ miles southeast of Warsaw. Taken from the bottom of a ditch 2 feet deep which leads from a marl pit where No. 2564 was found.

2632. Phosphate found in a ditch which divides farms of J. R. West and E. A. Merritt, 5 miles southwest of Warsaw, on south side of Stuart's creek, 3 feet below surface. Stratum 12 inches, and gives evidence of considerable quantity.

2633. Phosphate from farm of Thomas Turrence, 5 miles southwest of Warsaw, on south side of Stuart's creek, on Kenyon and other branches. Found in large quantities and nearly on the surface. Said to be a stratum of 2 feet, and a foot lower another stratum of 1 foot.

2634. Phosphate from the farm of A. West, 6 miles southwest of Warsaw, and south of Stuart's creek, on a tributary of said creek. Two and a half feet below surface in bottom of a ditch. Stratum 8 to 10 inches, and indications of some quantity.

2635. Phosphate from land of Jesse Swinson, 4 miles northeast of Bowden's. Three pits, 180 cubic feet earth excavated. Small quantity of rock.

2636. Phosphate from land of R. W. Boyette, 3 miles east of Bowden's; 2.08 acres, 86 23 tons per acre—total 179.35 tons. Ten pits, 750 cubic feet earth and 857 pounds rock excavated.

2639. Phosphate from farm of L. Aaron, 1 mile southeast of Warsaw, and adjoining farm of J. W. Best. Three feet below surface and in quantity. Stratum 8 inches.

2648. Phosphate from farm of Henry Best, 3 miles west of Warsaw, 4 feet below surface.

2650. Phosphate from farm of J. F. Croom, 1 mile east of Magnolia, on Kenansville road, 4 feet below surface, on top of marl. Stratum 8 inches. In fair quantities.

2651. Phosphate from natural well on land of M. West, 2 miles southwest of Magnolia, and near the road to Harrel's store, 12 feet below surface, under a stratum of white shell marl 4 feet thick, and on top of a solid bed of blue marl. Stratum 6 inches.

2653. Phosphate from farm of J. S. Taylor, 3 miles southwest of Magnolia.

2654. Phosphate from farm of J. R. Wells, 4 miles southwest of Magnolia. From surface; said to be in large quantities.

2655. Phosphate from farm of S. Boone (col.), 4 miles southwest of Magnolia.

2656. Phosphate from farm of A. S. Colwell, 8 miles west of Duplin road, on Iron Mine creek, 4 feet below surface, and seemingly in large quantities.

2742. Phosphate from farm of A. Rich, 2½ miles south of Faison's on W. and W. R. R., 3 feet below surface, in marl bed. Looks rich, black, massive. Quantity seems good. Stratum 8 inches, on stream tributary to Bear swamp.

2743. Phosphate from L. T. Hicks' farm, 3 miles southwest of Faison's, 3 feet below surface in marl bed, on branch tributary to Bear swamp. Quantity seems good. Stratum 8 inches. Rock black, sandy.

2745. Phosphate from C. C. Rick's farm, 2½ miles southeast of Faison's, near W. and W. R. R., 3 feet below surface in a branch tributary to Bear swamp. Stratum 6 inches. Black, quantity large.

2746, *a*, *b*, *c*, *d* and *e*. Phosphates from Lovette J. Lee, 6 miles northwest of Faison's. Nineteen pits. 1995 cubic feet earth and some rock excavated. Large quantity of Eocene marl and green sand. Light grey and white rounded nodules, some so soft that they can be mashed in the hand. Different looking specimens were analyzed separately.

2747. Phosphate from Mrs. M. E. Pass, 1 mile west of Faison's. Three pits, 360 cubic feet earth excavated. Some rock in large pieces under marl 10 to 12 feet deep.

2749. Phosphate rock from farm of Isham R. Faison, in the western suburbs of Faison's, about 6 feet below the surface, black and very massive. Stratum about 12 inches. Quantity seems good. The rock has been exposed for many years.

2751. Phosphate taken from a cut on Wilmington and Weldon R. R., ¼ mile west of Faison's. Found about 10 feet below the surface.

2757. Phosphates from cut on Wilmington and Weldon Railroad, ¼ mile north of Faison's, about 10 feet below surface. Quantity seems good. Found with marl. On a ditch tributary to Goshen swamp.

2801. Phosphates from the farm of Spiers Lanier, 18 miles southeast of Kenansville, on Halso swamp, tributary to Cypress swamp, thence to North East river. Specimens were thrown from about 3 feet below the surface. Stratum about 2 feet thick, consisting of top layer of reddish color, middle layer dark color, and bottom layer greyish color. Seems to exist in large quantities. Mound Spring in a few feet of this phosphate bed. Marl.

2802. Phosphates from farm of John Castine, 20 miles southeast of Kenansville, found near lands of Board of Education, in Angola Bay, under marl bed, about 8 feet below surface. Stratum of marl 4 feet thick.

2803. Phosphate rock from farm of Robert James, 20 miles southeast of Kenansville, in marl bed 3½ feet below the surface, on a ditch leading into Cypress creek at the upper lakes. Stratum about 6 inches.

2804. Phosphate rock from same locality as 2803. Stratum about 8 inches.

2805. Phosphate rock from same locality as 2803. Stratum about 8 inches.

2806–07. Phosphates from land of D. J. Middleton, Warsaw.

2808. Phosphate rock from the farm of J. B. Pearce, 2 miles northwest of Warsaw, on Clinton road, in marl bed 3 feet below surface. Stratum about 6 inches, on stream tributary to Turkey creek.

2809–10. Phosphates from the land of D. I. Woodard, Warsaw.

2811. Phosphate from the land of J. W. Best, Warsaw.
2812. Phosphates from the farm of W. A. Faison, 4 miles west of Warsaw, near Turkey creek, about 4 feet below surface. Quantity unknown. Marl.
2815. Phosphate rock from farm of Wm. Boyette, about 2½ miles west of Warsaw, on stream tributary to Stewart's creek, found 4 feet below surface. Quantity fair.
2816. Blue marl from farm of Ransom Middleton, 2 miles east of Warsaw, on Goshen swamp, found 3 feet below the surface.
2817. White shell marl from same locality as 2816, found 3 feet below surface.
2821. Phosphate rock from John Frederick's, 6 miles southwest of Warsaw. Found near the surface. Quantity small. No marl.
2822. Rocks from farm of W. H. Sloan, Chinquepin, on North East river, found in ditch 3 feet below surface. Quantity large. Marl.
3100. Phosphate taken from farm of Jno. Frederick, 6 miles southwest of Warsaw.
4423. Phosphate from the lands of Stephen Graham, Kenansville.

EDGECOMBE COUNTY.

34. Marl from land owned by Hon. K. P. Battle, Chapel Hill.
502. Marl from Jesse Mercer, Tarboro.
474. Marl from J. R. Thigpen, Tarboro.
513, 626–29. Marls from James R. Thigpen, Tarboro. No. 628 marked "9 miles from Tarboro and 9 feet below surface."
660. Marl from John S. Dancy, Tarboro.
984. Marl from J. R. Thigpen, Tarboro.
1205–06 and 1619. Marls from J. R. Thigpen, Tarboro.
2618. Marl from John Lancaster, Tarboro. It is of a yellowish color, containing shells and is found in large quantities on his farm on Town creek.
2865. Marl from M. Battle, Tarboro.
3075–76. White shell and blue marls with a little mud, from farm of Capt. T. W. Battle, Rocky Mount. Too little carbonate of lime, probably, to admit of use.
3468 and 3154. Blue marl with a few white shells, sent by Thomas H. Battle, of Rocky Mount, who writes: "The beds from which I send you samples, form part of an extensive bed, extending, more or less, on both sides of the Tar, from Rocky Mount to Tarborough. The deposit is extensive on some of the river farms, but has never been found on the others. It varies in thickness from 2 to 15 feet, and lies underground 2 to 12 feet. Sometimes the area of the bed is small, sometimes several acres—the extent never having been discovered. The beds from which these samples were taken lie on the two river farms of Mrs. K. P. Battle, about 6 miles apart, where the deposits are unusually large, how large I cannot tell. It has been found at various places, ¼ to ½ mile apart, but how much lies in the intermediate spaces we do not know. These beds lie about 6 feet under the surface and are about 10 feet deep." Poor in carbonate, but has a rather unusually large per cent. of phosphate.
3539, '40, '41 and '42, were samples of marl exhibited at Edgecombe Fair in 1885, and were sent to the Station for analysis by E. V. Zoeller, Secretary, Tarboro, N. C.
4181. Marl from the lands of Hon. W. R. Cox, known as the Poke Island Farm, which is located 200 yards from Tar river, on the south side of it, and half a mile from Rocky Mount and Tarborough road, 1½ miles from Kingsboro P. O. The bed is known to extend about 27 or 30 feet, is 6 feet thick and 4 feet below surface.
4222–24. Marls from lands of C. H. Blocker, located at Fishing creek. Designated as Nos. 1, 2 and 3. No. 1 is from a soft bed 10 feet thick, No. 2 from same bed with white shells and No. 3 contains lumps of bone.
4225–26. Marls from E. B. Hodges, Tarboro.
4284. Marl, white powder, from J. M. Mayo, Whitakers. "The hard or lumpy portion lies about 3 feet under the pulverized portion. Considerable quantities of it can be had."
4394. Marl from C. H. King, Tarboro. He writes: "Is on my place about 3 miles from Tarboro. It is in a ravine, running from Tar river, extending 40 or 50 yards into the field. I have never been able to cut through the bed, but have cut 13 feet when it caved. There is a strata of light or red marl of about 3

feet over this bed. This bed extends to length of ravine and is found plentifully on the river when the water is low."

4460–61. Marls from E. B. Hodges, Tarboro.

4486. Marls from land of Dr. A. B. Nobles, Tarboro. No. 1 greyish color. "The marl sent was from my farm, 8 miles west of Tarboro, and on a small branch running up in my farm. I accidentally found that it was good by digging and putting it on some very poor land, and it filled me with surprise, and since then I have used it on several places on my farm, and always with marked results. I am sure it covers 1, 2 or more acres, and possibly several. It is about 4 feet from top of ground and about 6 feet deep, and may be more. The four samples come from same bed, but are different layers, as there seemed to be a difference in composition and color. The layers are about 18 inches thick and the No. 1 came from the top, although at the bottom it is about the same, and now I am inclined to think, after going through the soft substance, I may get some that is richer. There are cliffs all through the marl bed, but in the middle of the bed comes the dark marl, but that is not very extensive. I am satisfied that the marl has done much good to the land, as it is about the best land I have. Will make most anything."

4487. Dr. A. B. Nobles, Tarboro. No. 2 yellow marl. Came from same bed as No. 4486.

4488. Dr. A. B. Nobles, Tarboro. No. 3 shell marl. Came from same bed as 4486, third layer.

4489. Dr. A. B. Nobles, Tarboro. No. 4 marl. Came from same bed as 4486, fourth layer.

4522. Marl from T. H. Battle, Rocky Mount.

4966. Marl from G. A. Stancil. No. 1 "Is gotten about 8 feet under surface."

4967. Marl. No. 2. Found in same bed as 4966 and just below it.

5527–28. Marl from Robert Pitt, St. Lewis, who writes: "The samples of marl were dug out of a pit on my land, in a swamp leading into Town creek, situated in Township No. 10. The marl is about 4 feet from surface, 12 or 15 feet thick and seems to be 50 or 60 yards wide and about ½ mile in length." One of the samples was sent just as it came out of the pit and the other was dried and ground.

6151. Marl sent by Judge Fred. Philips, Tarboro.

6273–74. Marls from the land of E. L. Pitt. Bed is situated about 200 yards from Town creek in Township No. 10. It is 6 feet below the surface, 6 feet thick and covers 1 acre or more.

6303–04. Marls from the land of Robert Pitt, situated about 2 miles north of St. Lewis. The bed is 4 feet below the surface and is 8 to 10 feet thick.

6554. Marl from the farm of D. H. Barlow, situated 3 miles south of Tarboro.

3279. Phosphate rock from the farm of Dr. A. B. Nobles, of Tarboro. The sample was found 8 miles west of Tarboro and 3 miles from the Tarboro branch railroad, on Tyancoka swamp. The quantity is large, and marl is found with the phosphate.

3772–74. Samples of phosphate rock from Dr. A. B. Nobles, Tarboro.

FRANKLIN COUNTY.

4908–09. Marls from Rev. C. O. Durant, Youngsville.

GREENE COUNTY.

257. Marl from Dr. Ben. S. Hardy's farm, 8 miles east of Snow Hill.

258. Marl from farm of John Sullivan, on Sandy run swamp, 8 miles north of Snow Hill.

2320–22. Marls from land of Levi J. H. Mewborn, Snow Hill; 2320 "from top, lightest colored"; 2321, "bored up with an auger, dark brownish grey"; 2322, "dug up, dark greenish."

2577. Marl from same bed as 2322, near surface.

4285. White shell marl from Hon. E. C. Blount, Willow Green.

4359. Blue marl from Jno. P. Gray, Snow Hill. "Is located on Tyson's marsh, about 5 miles southwest of Snow Hill. The extent unknown, as I have been unable to make a thorough investigation. More than ever will be dug out. I did not go through in the bed I did dig. I went down about 11 feet, 6 feet in the marl and about 5 feet before I reached it. It was bored up in several other

places. Mr. L. J. H. Mewborn has plenty of it just opposite this bed. I dug across the marsh, and had it analyzed by the Station, number of analysis 2322, contained phosphate of lime 24.82 per cent. Some places it is under rock so I cannot bore through to it."

4938. Marl sent by Jno. P. Gray. "Ploughed up in the vicinity of a hole that had been dug."

5717. Marl from B. T. Mooring, Jason.

HALIFAX COUNTY.

2571. Marl sent by R. H. Smith, Scotland Neck. Found on Kehukee creek, near land of S. W. Edwards, 4 to 6 feet below surface.

2572. Marl found on land of B. D. Webb, on Clark's branch. Sent with 2571.

2573. Marl from land of S. W. Edwards, near Scotland Neck, 20 feet below surface. Sent with 2571.

2574. Marl from land of Mr. Griffin, near Scotland Neck. Sent with 2571.

2575. Marl from land of J. B. Hall, Clark's branch. Sent with 2571.

2765. Marl from J. R. Tillery, Tillery.

3355. White shell marl from farm of Wm. E. Fenner, Halifax. The bed is about 3 feet thick, and is found on the surface, on the bank of the Roanoke river, 5 miles northeast of Halifax. The size of the bed is 75 x 100 feet. This marl is better than the average of marls, in that it has a fair percentage of phosphate.

3403. Blue marl from farm of H. B. Morse, Palmyra. Found on top of ground and no vegetation will grow on it.

4413. Blue marl from Ashley Wilkins, South Gaston. He writes: "I found the sample near (1 mile off) Palmyra, in the extreme lower edge of Halifax county, on the Roanoke river. It juts out on the river and seems to run back about a ½ of a mile or so from the river, judging from the hill."

3763. Marl sent by E. T. Branch, Enfield. From "Creek Farm," 1 mile east of Enfield, where it is found in inexhaustible quantities.

3764. Marl from the land of John S. Gregory on Roanoke river, adjoining the town of Halifax. There is a long ridge of it lying immediately on the Roanoke river.

HERTFORD COUNTY.

2211. Marl from Tyroone Spiers, Como.

3696. Marl sent by T. H. Debnam, Winton, who writes that "the bed is 100 yards from Winton, on the lands of J. L. Anderson, 100 yards from Chowan river. Bed is about 8 feet below the surface and is supposed to be very thick."

6408-10. Samples of marl from a deposit on the Meherrin river, near Murfreesboro. Sent by John Brewer, Murfreesboro.

6456. Marl from banks of Meherrin river, on land of J. M. Wynn, Murfreesboro. Sent by E. C. Wand, Murfreesboro.

6457. Marl from a deposit on the Meherrin river, on land of J. R. Hall, Murfreesboro. Sent with 6456.

8235. Marl from farm of J. C. Drake, located in Hominy Neck township.

JOHNSON COUNTY.

2937. Marl from H. M. Bizzle, Glenwood.

JONES COUNTY.

259. Marl from farm of H. C. Koonce, on Trent river, near Comfort.

260. Marl from farm of Dr. C. J. Mattock, 3 miles above Pollocksville. Taken from a branch.

261. Marl from same locality as 260. Taken out of hill above the branch.

262. Marl from Frank Foy, Pollocksville.

653-654. Marl from A. T. Uzzell, Tuckahoe.

2425. Phosphatic marl from the farm of A. P. Barrow, Pollocksville.

2426. Marl from land of J. P. Harper, Pollocksville. Came with 2425.

2584. Rock from the land of W. A. J. Pollock, Kinston. The rock was found near Trent river and Chinquepin creek, 2 to 4 feet below surface, on top of a bed of marl.

2585-87. Marls from same locality as No. 2584, 6 inches to 10 feet below the surface. Quantity very great.

2588. Marl from same locality as No. 2584, found on surface.
4618. Marl from farm of L. J. Haughton. Sent by W. M. Jones, Kinston.
4468. Grey marl from L. Harvey, Kinston. It came from a bed situated on the farm of J. M. Wooten, 5 miles from Kinston, south side of Neuse river. "The bed is about ¼ of a mile from Caswell depot. A. and N. C. R. R. I think there are 5 or 6 acres of the marl. The bed is in Jones county, just over the Lenoir line. We have opened four pits. One pit we cut 7 feet in marl and struck no rock. The dirt covering the marl is from 2 to 6 feet deep. There are many thousand tons in the bed. The bed is connected with 112 acres of fine farming land. There are two public roads running near the bed, one about 100 yards, the other about 250 yards. Think we have 3 or 4 acres more of marl on a branch running into Cabin branch."
6405–06. Marls from the land of C. H. Foy, 8 miles south of Kinston, in Beaver Creek township. The samples were found 4 to 5 feet below the surface.
3279. Phosphate nodules found in a ditch, 2 feet below the surface, 1 mile south of Core creek station, on the new Trenton road.

LENOIR COUNTY.

433–35. Marls from S. E. Hodges, Falling Creek.
436–7. Marls from Noah Rouse, La Grange.
438. Clay marl from B. F. Herring, La Grange.
440. Shell marl from Thomas Dawson, La Grange.
645 and 658. Marls from S. J. Sutton, La Grange.
1340. Ground oyster shells from L. H. Harvey, Kinston.
1637. Marl from the land of E. S. Broadway, Kinston.
1645. Marl from E. Grady, Kinston.
2162. Marl sent by Seth West, Kinston.
2209. Phosphate rock sent by Dr. H. O. Hyatt, Kinston.
2427–35. Samples of marl taken by W. G. Lewis of the Phosphate Survey. Nos. 2427-29 were taken from the farm of J. C. Woolen, 9 miles from Kinston; No. 2430 from the farm of Gabriel Cox, south of Vine swamp; Nos. 2431–32 from farm of David Gooding, 1 mile east of Gabriel Cox; No. 2433 from the farm of Isaac Johnson, 2 miles northeast of Woodington church; No. 2434 from the farm of Fred. Jones, 8 miles from Kinston; No. 2435 from farm of J. Aldridge, near Kinston.
2478. Marl from W. B. Nunn, Kinston. Found in a swamp 3 feet from the surface. Quantity large.
2953. Marl from the farm of George Philips (col.), located about 5 miles from Kinston on Cabin branch and 1½ miles south of Neuse river. The deposit covers an area of about 5 acres and is found 4 to 5 feet below the surface. The bed is 8 to 10 feet thick.
3245. White shell marl (finely ground), sent by L. J. Moore, Kinston. The deposit is situated about 3½ miles south of Kinston, is about a mile in length and 10 to 15 feet thick.
4467. Marl from L. Harvey, Kinston.
3658. Shell marl with nodules, from Dr. H. O. Hyatt, Kinston. Taken from a bed 1 to 2 feet thick and 1½ miles in extent. The bed is south of Kinston and 12 miles from the region explored by the survey under Gen. Lewis.
4741. Marl from A. B. Nobles, Kinston.
4837–40. Samples of marl from A. J. Kilpatrick, Kinston; 4837 is red clay of marl bed; 4838 top of marl, grey; 4839 bottom of marl shell and sand; 4840 bottom of marl bed, green sand.
6041. Marl from the farm of B. F. Sutton, situated 1 mile from the mouth of Bear creek, 6 miles below White Hall, 6 miles from La Grange and 12 miles from Kinston. The top of the deposit is very hard for 12 inches or more, but underneath this it is easily dug out. Sample was taken 6 feet from top of marl and has been dug 12 feet without going through. Quantity very large.
6162. Supposed phosphate rock from farm of J. M. Kilpatrick, La Grange.
6837. Marl from the farm of P. H. Mewborn, 10 miles south of Kinston.

MARTIN COUNTY.

2277. Marl from William Slade, Williamston.
2286. Shell marl from N. S. Peal, Williamston.

2885–86. Marl from Amos Robinson, Everett's. "The beds are situated about 12 miles southest of Roanoke river, on Tranters creek."

MONTGOMERY COUNTY.

8733. Marl received from J. W. Thompson, Raleigh. With reference to this marl J. C. Currie, Candor, writes: "The sample of marl was found a few miles west of Candor, and it is supposed that it is there in quantities."

NASH COUNTY.

681. Marl from T. P. Braswell, Battleboro.
2625. Marl from J. H. Enniss, Raleigh. Ground by Carter Pope, Battleboro.
3587. Marl from W. E. Philips, Battleboro.

NEW HANOVER COUNTY.

410–13. Marl and phosphate conglomerates from Cronley & Morris, Wilmington.
507. Marl from Charles B. Stubbs, Swift creek bridge.
508. Blue marl from Cronley & Morris, Wilmington. "Found in large quantities."
509–11. Samples of phosphate rock sent by Cronley & Morris, Wilmington.
879. Marl sent by Fred. D. Thorn, Wilmington. Taken from deposits near Wilmington.
1279. Marl from the land of D. McRae, near Wilmington.
1981, 1982 and 2029 are single nodules taken from the conglomerate at Castle Hayne.
1983. Conglomerate sent by Dr. T. D. Hogg, Raleigh.
2100–02. Phosphate nodules from the marl pits of S. W. Noble, Wilmington.
2103–04 and 2101. Samples of conglomerate from same locality as 2100.
2132. A collection of nodules ground together, from Castle Hayne.
2231. Burned rock from Castle Hayne.
2250–51. Samples of phosphate from Castle Hayne, burned, water-slacked and sifted. 2250 is the fine portion passing through the sieve; 2251 is the coarse portion left on sieve.
2333. Ground conglomerate from Castle Hayne.
2344–45. From Castle Hayne; 2344 represents nodules left on sieve after sifting; 2345 powder passing through the sieve.
2422. Phosphatic marl from Cronley & Morris, Wilmington.
3187. Phosphate rock from Castle Hayne. Sent by Colin M. Hawkins, Raleigh.
3261. Phosphate from Castle Hayne. Sent by P. H. Andrews, Raleigh.
3417–18. Phosphate from Castle Hayne. Sent by P. M. Wilson, Raleigh.
3536. North Carolina lime phosphate (the ground phosphatic lime conglomerate), manufactured by North Carolina Phosphate Co., and sent for analysis by Bernardt & Co., of Pioneer Mills.
3548. Phosphate from Castle Hayne. Sent by C. M. Hawkins, Raleigh.
3775. Ground phosphate from the North Carolina Phosphate Co., Raleigh. Conglomerate from Castle Hayne and ground at the company's works.
3795. Ground phosphate from same locality as 3775. Sent by T. Ivey Ashpole.
3854. Floats prepared at the North Carolina Phosphate Co.'s works, with Cyclone mill. Phosphate from Castle Hayne. Sent by Dr. T. D. Hogg, Raleigh.
3926. Blue marl from Castle Hayne. Sent by Dr. T. D. Hogg, Raleigh.
4234–35. Phosphates sent by C. M. Hawkins, Raleigh, from Castle Hayne.
4594–95. Phosphates sent by Marmaduke Hawkins, Raleigh, from Castle Hayne.
3930. Loose nodules from Castle Hayne. From underneath the conglomerate bed and several feet in thickness. Received from the North Carolina Phosphate Co., Raleigh.
4604–06. Ground phosphate from P. M. Wilson, Raleigh.
4884–86. Phosphate nodules from Castle Hayne; 4884 finest; 4885 medium; 4886 coarser. All sent by P. M. Wilson, Raleigh.
4933–34. Ground phosphate from P. M. Wilson; 4933 fine; 4934 coarse.
5714. Phosphate sent by C. M. Hawkins, Raleigh.
6153. Marl from the land of Mr. Bowden, near Wrightsville. Sent by H. W. Malloy, Wilmington.

NORTHAMPTON COUNTY.

3290. Blue marl from the farm of Dr. J. E. Stancill, who writes that the "bed is situated about 2 miles southwest of Margarettsville, on the Seaboard and Roanoke Railroad. It is about 250 yards in length. I have sunk the pit about 10 feet without going through the marl. I cannot tell the width, but it is considerable."

8718. Marl from the land of W. J. Edwards, Severn, known as the "Marl Hill Farm." The bed is located on the Meherrin river, 2 miles west of Severn station. "Both the blue and red varieties are to be found in inexhaustible quantities."

ONSLOW COUNTY.

2494. Rock from farm of David Sandlin, south side Cohen's creek, 3 miles northeast of Richlands.

2495. Coprolites from the farm of J. M. F. Brock, 2 miles northeast of Richlands. From bed of a ditch. Said to be in large quantities, and in Jenkins' branch very accessible.

2496. Coprolites from the farm of L. Franks, 2 miles northeast of Richlands, and north side of Cohen's creek and near White Oak swamp. Found on the surface on the side of a hill.

2590. Phosphate from the land of A. B. Carroll, located on the west side of White Oak river, 6 miles from Maysville and 10 miles from Pollocksville. Found near surface. Sent by Geo. Allen & Co., Newbern.

2818. Phosphates from farm of A. H. Rhodes, 2 miles northwest of Tar Landing on New river. Found in a branch about 4 feet below surface. Marl.

2819. Phosphates from Allen Murrill's farm at Tar Landing, New river, about 4 feet below surface. Marl.

2820. Phosphate rock from farm of Christopher Stevens, 11 miles northwest of Jacksonville. Found in side of a hill cut by country road, about 4½ feet below surface. Quantity fair. No marl, but abundance of lime rock.

2832–33. Marls found on the farm of A. B. Carroll. Located west side of White Oak river, between river and Great Pocosin. Found near surface in large quantities. Sent by Geo. Allen & Co., Newbern.

4233. Yellow marl taken from a bed on the Barry plantation, a few miles east of Richlands. Sent by Dr. J. L. Nicholson, Richlands.

6942. Phosphate from land of H. W. Nixon, 3 miles east of Topsail Sound P. O.

6464. Shell marl from the land of G. R. Venters, Green branch. It is found on the bank of New river, 4 feet below the surface and is 2 feet or more in thickness.

8623. Marl from the land of H. D. Murrill, Jacksonville. The bed is situated 5 miles south of Jacksonville, near the mouth of the southwest branch of New river. Thinks there are 10 or more acres in the deposit.

PASQUOTANK COUNTY.

4821. Marl from Col. R. B. Creecy, Elizabeth City, who writes: "From a section known as Tadmore, the most fertile part of the county, where reside the best farmers. The bed is inexhaustible, lying about 5 feet below the surface and is 10 miles square."

PENDER COUNTY.

1278–79. Limestone from French Bros., Rocky Mount, marked "From Excelsior Quarry."

2221 and 3747. Marls from the land of Nicanor Powers, South Washington, 1 mile from the Wilmington and Weldon R. R. Said to be in large quantities.

2097, 2098, 2109 and 2130. Phosphate nodules from the conglomerate at French Bros.' quarry, Rocky Point.

2099 and 2222. Conglomerates from same locality as 2097.

2223. Same as 2222 after being burned.

2250. Phosphate conglomerate from French's quarries, Rocky Point, burned, water-slacked and sifted. This is the fine portion passing through the sieve.

2251. Nodules from 2250, with considerable lime still adhering.

2657. Phosphate from farm of J. Alderman, 8 miles southwest of Duplin road, 3½ feet below surface, in a ditch on south side of Doctor's creek.

2757. Phosphate rock from farm of C. P. Moore, 5 miles northeast of Point

Caswell. Found in marl bed about 4 feet below surface. Stratum about 8 inches. Quantity apparently good. On a stream tributary to Moore's creek.

2758. Small nodules found in marl bed in same locality as 2757, 4 feet below surface. Stratum about 8 inches. Quantity apparently good.

3239. Phosphate rock sent by Gen. W. G. Lewis, of Goldsboro, from near northeast Cape Fear river, above French Bros.' quarry and on the same side of the river. The surface of the country is level, and the rock looks much like the South Carolina rock.

3526. Ground phosphate, sold as coprolite manure by French Bros., of Rocky Point. The sample was taken from the Excelsior Quarries of the French Bros.

3753. Supposed phosphate from French Bros., Rocky Point. A ledge, not a conglomerate, composed mostly of carbonate of lime.

2267–68. Phosphate rock from Geo. Z. French, Rocky Point; calcined, waterslacked and screened; 2268 is the nodules and coarse portion left on the screen.

4429. Phosphate rock from Col. Geo. Z. French, Rocky Point, who writes: "They are undoubtedly the most promising specimens yet discovered in North Carolina. Located in southeastern section of North Carolina. Not sufficiently explored to determine extent. It is probably a large bed, but it is so deep from the surface and so far from good facilities for railroad or water transportation that it is doubtful if it can be worked successfully for years to come."

4430. Phosphate rock from Col. Geo. Z. French, Rocky Point. Came from same place as No. 4429.

4536. Phosphate rock from N. W. Powers, South Washington. "It was taken from my farm on the northeast branch of the Cape Fear river, 1 mile from the W. and W. R. R., in the upper end of Pender county. The rocks lie on and near the surface of the ground and cover 100 or 200 acres of land."

5292. Phosphate rock (conglomerate) from Geo. Z. French, Rocky Point.

5293. Phosphatic lime from same locality as 5292.

6942. Phosphate from the land of Hill W. Nixon, Topsail Sound, 3 miles east of Topsail P. O.

PERQUIMANS COUNTY.

2576. Marl from Joseph Moore, New Gardner. Found near Belvidere, 2 to 3 feet below surface. Quantity large.

PITT COUNTY.

1330. Marl from W. H. Cox, Greenville.

1331. Marl from E. A. Johnson, Johnson's Mills.

2883. Blue marl from the land of Wm. and Council Dawson, Scuffleton. Located 15 miles south of Greenville and 1 mile from Contentnea creek. The bed covers about 150 acres and in some places is not more than 3 or 4 feet from the surface. Thickness unknown.

2884. White shell marl from the land of James Dawson, Ridge Springs. Sent by Allen Warren, Greenville, who writes that "the bed is about 75 acres in extent."

2998. Blue marl sent by C. C. Kirkman, of Coxville. The marl is from the farm of A. Williams, 1 mile west of Newbern road and 12 miles south of Greenville. The bed is about 5 acres in extent and is found 6 to 8 feet below the surface.

2999. Blue marl sent by C. C. Kirkman, of Coxville, from the farm of John Branch. The bed is 300 by 200 yards in extent and about 5 feet below the surface. It is located 13 miles south of Greenville, ¼ mile from the Nelson road.

3003. Blue marl, with white shells in it, from the farm of J. G. Shepard, of Farmville. Small amount of lime for marl, but large amount of phosphate.

3119. White shell marl from the farm of G. W. Venters, Calico.

3120. Marl from land of N. H. Hathaway. Sent with No. 3119.

3280. Shell marl sent by Maj. Jos. H. Saunders, of Pactolus, from the farm belonging to Mrs. Wm. Grimes, of Raleigh. The bed is on Bear creek, 6 feet below the surface, and is valuable as a fertilizer, in some cases doubling the yield. Most excellent marl—the per cent. of phosphate and potash being a good one in addition to carbonate of lime.

3554–3556. Blue marl sent by L. B. Burney, of Johnson's Mills, who writes:

"The beds are on Swift creek, 4 miles north of Johnson's Mills. Nos. 3554–3556, which differed in appearance, were taken from the same bed, at depth of 10 feet. The extent of the bed is 2 or 3 acres. No. 3555 was taken from another bed 6 feet deep, extent about 1 acre, thickness unknown." 3554 is a fair marl; 3556 is a very poor one.

4217. White marl from the land of Jas. A. Stokes. Sent by J. M. Dixon, Johnson's Mills.

4219. Marl sent by Maj. R. S. Tucker, Raleigh, from his farm at Pactolus. The bed is situated on Grindel creek and is under the surface on the entire north side of the creek. Is 1 mile north of Pactolus landing on Tar river. The bed is ¼ a mile wide and only 2 feet below the surface; thickness unknown.

4220. Marl sent by Maj. R. S. Tucker, from his farm near Pactolus; is 2½ feet below the surface, the land being known as the Robfield. It is found on Tar river, where the high and low river lands meet, and has been found at different places, where excavations have been made, for ½ a mile up and down the river.

4221. Marl from the farm of R. R. Fleming, on Tranter's creek, near the road leading from Pactolus to Washington, and is found in beds similar to the above beds on Major Tucker's farm.

4459. Marl from Senator W. R. Williams, Falkland, who writes: "Came from a hill on my farm, about 1 mile from Tar river, and ½ mile from Otter creek. It has a slightly bluish look but clear."

4527. Marl from T. W. Stokes, Johnson's Mills. "Located on west side of Clay Root swamp flat lands. Extent of bed, as far as been, I suppose 10 or 12 acres. Depth to the marl from 4 to 6 feet. I have been 12 feet down and have never been through."

4943. Marl sent by Allen Warren, Greenville.

5596. Marl from the land of J. H. Clark, near Conetoe. The bed is situated on Conetoe creek; it is about 5 feet from the surface and 9 feet thick.

8047–48. Marls from Fred. F. Brooks, Grifton. "Situated on my land 2 miles northeast of Grifton, at the base of a hill running east and west. The red is from 1 to 3 feet deep, then comes the blue of unknown depth; has been dug 10 feet."

8350. White shell marl from C. C. Kirkman, Redalia, who writes: "There are 8 to 10 acres of it." Sent through W. H. Worth, Raleigh.

ROBESON COUNTY.

1434. Marl from near Lumberton. Sent by Dr. C. W. Dabney, Raleigh.

1740. Marl from E. P. Higby, Lumberton.

3882. White shell marl from J. E. Ashley's farm, 1 mile from Ashpole. "The bed is probably 4 feet thick, 3 feet below the surface, and underlies 1 acre. The bed lies above high water on the banks of a small swamp, and has a great variety of shells and some bones. The marl decomposes very rapidly."

4914. Marl from the farm of A. C. Oliver, Jr., situated on Ashpole swamp, 18 miles south of Lumberton.

SAMPSON COUNTY.

1126. Phosphatic marl from A. S. Colwell, Harrell's Store.

2131. Green sand marl from A. S. Colwell, Harrell's Store.

2383–84. Marls from A. J. Smith, Taylor's bridge. Quantity large.

2423–24. Marls from A. S. Colwell, Harrell's Store.

2534. Marl from W. M. Kellett, Clinton. Found beneath a stratum of shell marl; contained a few bones, etc. Quantity large.

2706. Marl from A. J. Smith, Taylor's Bridge.

3538. Marl from J. R. Harris, Owensville, who writes: "The marl is found in the swamp of Little Coharie creek. It is in veins, and those are from 2 to 4 feet wide and from 6 to 10 inches thick. From the growth I think it covers about ½ acre. It lies on the west side of Little Coharie creek and 12 miles west of Clinton."

6373. Rock marl from the land of T. W. Underwood, Newton Grove.

7881. Marl from the land of R. G. Morrisey, located 4 miles east of Clinton, on the road leading from Clinton to Warsaw. "Very abundant."

2557. Phosphate from farm of W. H. Faison, 6 miles southwest of Warsaw. Found in a ditch 2½ feet below the surface.

2558. Phosphate from the land of Edward Mann, 7 miles southwest of Warsaw.

2559. Phosphate from the land of A. J. Daniel, 7½ miles southwest of Warsaw.

2658. Phosphate from the farm of F. Johnson, 1 mile east of Harrell's store, on Powell creek, 3 feet below surface.

2659. Phosphate from J. F. Taylor's farm, 1 mile east of Harrell's store, on Powell creek, 3 feet below surface.

2660. Phosphate from Lewis Highsmith's farm, 1 mile south of Harrell's store, 3½ feet below surface.

2661. Phosphate from T. N. Fennell's farm, 1 mile south of Harrell's store, on Pharisee creek (a tributary of Doctor's creek), 3½ feet below surface.

2662 *a* and *b*. Specimens of bones from the farm of T. N. Fennell, 1 mile east of Harrell's store, from ditch 2 feet deep.

2663. Phosphate from R. P. Matthis' farm, 3 miles east of Clinton, on plank road, 3½ feet below the surface, on a branch tributary to Six Runs.

2664. Phosphate from W. K. Pigford's farm, 4 miles north of Clinton, 4 feet below surface, on a branch tributary to Six Runs.

2665. Phosphate from L. A. Powell's farm, 10 miles southeast of Clinton, 5 feet below surface in marl bed. Stratum about 6 inches.

2666. Phosphate from Rev. Allen Whitfield's farm, 6 miles north of Clinton. Found 3 feet below surface, in seemingly large quantities, in a stream tributary to Six Runs. Stratum about 6 inches.

2667. Phosphate from J. H. Pugh's farm, 1½ miles north of Clinton, 2½ feet below surface, on a stream tributary to Great Coharie. Stratum about 8 inches. Quantity seems large.

2668. A phosphatic rock from Louis M. Boykin's farm, 8 miles southwest of Clinton, on the Great Coharie, comes with this legend: "Found on the second low grounds in considerable quantities. It is supposed to contain some phosphoric acid and potash, because, as Mr. Boykin says, the crop of corn is always double where this rock underlies the surface. Found on the surface and 1 to 2 feet below." It contains, besides phosphate of lime, a very small amount of potash and soda. Unquestionably this must enrich the soil in contact with it.

The next four specimens were marked "Coprolites," a term which has been used to designate supposed fossil excrements, as distinguished from the common phosphate rock. It is a mistake. They are only worn specimens of the ordinary phosphate of this section.

2669. "Coprolites" from Spencer Merritt's farm, 13 miles southeast of Clinton, 2 feet below the surface. Large quantity.

2670. "Coprolites" from farm of J. D. Carter, 17 miles south of Clinton, in a marl bed 4 feet below surface.

2671. "Coprolites" from farm of J. H. Pugh. Quantity good. Has a glazed surface.

2672. "Coprolites" from farm of L. A. Powell, 10 miles southeast of Clinton, in marl bed 5 feet below surface. Large quantity.

2673. "Coprolites" from farm of D. B. Nicholson, 8 miles southeast of Clinton.

2739. Phosphate rock from J. B. King's farm, 6 miles west of Faison, on Clinton-Goldsboro road, 3 feet below surface, on tributary to Six Runs. Black; very massive. Stratum 8 inches.

2740. Phosphate rock from A. H. King's farm, 11 miles northwest of Faison's, on Faison-Raleigh road, 3 feet below surface in Six Runs. Very massive; quantity seems good. Stratum 8 inches.

2741. Phosphate rock from J. C. Hobbs' farm, 14 miles northwest of Faison's, at Hobbs' Cross Roads. Found in a tributary to Great Coharie, 2 feet below surface. Gray and massive. Stratum 6 inches.

2753. Phosphate rock from farm of F. M. Herring, 15 miles southeast of Clinton. Found just below the surface. Large quantity. Mr. Herring says corn produces a double quantity where this rock exists. On a stream tributary to Six Runs.

2814. Coprolites from farm of John D. Carr, on Black river, about 20 miles southeast of Clinton. Found about 4 feet below surface. Quantity unknown. Found with marl.

STOKES COUNTY.

4023. Limestone from the land of L. H. Hill, Germantown.

4517. Limestone from Dr. W. A. Lash, Walnut Cove, who writes: "This piece of limestone was taken from the lands of the widow of Calvin Morris, 2 miles from the line of the C. F. and Y. V. R. R., and 4 miles west of Walnut Cove."

4518. Limestone from Dr. W. A. Lash, Walnut Cove, who writes: "The piece of limestone was taken from the land of A. H. Morris, on the C. F. and Y. V. R. R., 1 mile east of Germantown."

WAYNE COUNTY.

101 and 122. Marls from deposits near Goldsboro. Sent by J. J. Whitehead, Raleigh.

121. Marl from Dr. B. F. Arrington, Goldsboro.

125–26. Marls taken by Prof. W. C. Kerr from Dr. B. F. Arrington's farm near Goldsboro.

2242. Marl from George C. Moore Goldsboro.

2697. Marl from N. W. Musgrove, Goldsboro.

3407. White shell marl from the farm of Col. J. W. Isler, La Grange, 9 miles northeast of Goldsboro, 3 miles from W. and W. R. R., and underlies 5 to 6 acres.

3159. Blue marl from the farm of J. H. Parks, Goldsboro. The marl is found 4 to 6 feet below the surface, on Bear creek, 7 miles east of Goldsboro and 1 mile east of the A. and N. C. R. R. It has been dug to 25 feet in depth and the bottom not yet reached.

4960–61. Marls from T. B. Parker, Goldsboro.

6614. Lime rock from a deposit near Goldsboro. Taken from the bottom lands where water runs over it. Deposit several acres in extent.

7154. Marl from the lands of Cox & Borden, situated on the N. C. R. R., 9 miles from Goldsboro.

7254. Marl from a deposit on the land of J. P. Cox, Walter, located on the N. C. R. R., 7 miles from Goldsboro.

WILSON COUNTY.

468. Blue marl from F. M. Roundtree, Wilson.

499–500. Marls from James Bryant, Wilson.

671 and 673. Marl from W. P. Carraway, Wilson.

1013. Phosphatic marl from Jesse Mercer, Toisnot.

3096–3098. Yellow earth, supposed to be marl, 4 feet below the surface: 3097, 8 feet below the surface; 3098, white shell marl, 12 feet below the surface.

3099. A mixture of the above three samples, sent by Dr. A. G. Brooks, from the farm of L. F. Lucas, of Lucama. The beds are found on a small branch near Lucama, and the extent is unknown. The beds have been dug to a depth of 20 feet and the bottom is not yet reached.

4203. White shell marl from H. Winstead, Toisnot. The bed is located 3 miles west of Toisnot, on Town creek swamp, near county road leading from Tarboro to Raleigh.

4787. Marl from Dr. A. G. Brooks, Black Creek.

ANALYSES OF MARLS AND PHOSPHATES OF NORTH CAROLINA.

[See Page 472 for Description of Deposits.]

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
	Beaufort Co.					
3287	White shell marl.	R. W. Wharton, Washington.	1.83	77.16	13.74	trace.
3288	Impure marl	" " " "	0.50	82.72	1.54	"
3347	White marl	W. A. Blount, Chocowinity			65.86	0.50
4482	Sand marl	F. S. Stickney, Yeatesville	.53	85.39	12.42	
4524	Marl, top layer	C. F. Warren, Washington	1.54	30.76	62.57	0.10
4525	Marl, second layer	" " "	4.73	80.25	5.73	
4526	Marl, third layer.	" " "	3.66	76.10	12.42	0.25
	Bertie Co.					
2567	Marl	H. V. Dunston, Windsor	1.02	63.71	29.82	small am't.
2568	"	" " "	0.70	11.20	83.10	"
3963	Blue marl	D. Bell, Avoca		68.82	19.86	0.50
3964	Yellow marl	" " "		63.04	28.14	1.00
4903	Marl	F. D. Winston, Windsor	0.96	68.15	19.21	0.20
4968	"	" " "	8.21	35.79	63.39	trace.
6481	"	J. H. Brazemore, Lewiston	17.85	65.91	13.90	"
7550	"	W. R. Capehart, Avoca	1.18	56.52	36.48	0.00
7551	"	" " "	0.24	76.24	22.09	0.00
8261	Gray marl	T. B. Davis, Windsor	1.44	62.18	31.39	trace.
8262	Yellow marl	" " "	1.41	65.81	28.42	0.00
	Bladen Co.					
35	Marl	J. G. Blue, Elizabethtown	5.69	41.79	49.50	0.77
2856	White shell rock	R. H. Lyon, "		0.48	94.00	trace.
2857	" " "	" " "		0.65	91.14	"
2858	" " "	" " "		1.04	93.93	"
2905	Phosphatic marl	D. A. Lamont, Brinkland			large am't.	1.58
3150	Blue marl	W. J. Sutton, Little Sugar Loaf		61.80	32.56	1.00
3151	White shell marl	" " " " "		31.53	57.48	3.00
3742	Marl	Dr. J. S. Devane, Brinkland	0.82	65.70	23.26	1.54
3794	Earthy marl	" " " "		50.33	0.00	0.50
4607	Lime rock	L. G. Hall, Elizabethtown		53.12	45.76	
5618	Marl	E. N. Robeson, Tar Heel	1.32	50.10	44.38	1.09
6173	"	K. J. Brady, Westbrook		30.66	61.14	trace.
6174	"	" " "		38.35	59.33	0.84
6175	"			48.41	48.75	trace.
6389	"	Mrs. E. P. Guion, Lyons Landi'g		75.22	20.61	1.15
6390	Phosphate rock	" " " " "		43.72	16.70	36.71
6510	Marl	E. N. Robeson, Tar Heel		58.00	18.72	trace.
6512	"	" " " "		86.98	trace.	"
6511	Fossilized bone	" " " "				8 to 10
2759*a*	Phosphate rock	Black Rock on Cape Fear river	8.34	33.39	9.05	47.83
2906	Coprolite	D. A. Lamont, Brinkland				16.56
2907	"	" " "				14.43
3743	"	Dr. J. S. Devane, Brinkland		43.63	30.38	13.89

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
	Brunswick Co.					
3275	Marl	Henry Addix, New Supply	4.20	63.40	22.88	trace.
	Chowan Co.					
4297	Shell marl	J. M. Hayes, Barnitz	0.24	1.24	95.12	
4485	" "	" " "		1.75	91.89	1.82
	Columbus Co.					
514	Marl	Whiteville Wine Co., Whitev'le		42.14	39.55	trace.
515	"	" " " "		44.00	33.92	
1615	"	Navassa Guano Co., Wilming'n		62.96		5.34
2198	"	J. L. Manning, Peacock's Store		31.87	64.02	
2330	"	Acme Mfg. Co., Wilmington		50.31	45.37	
2331	"	" " " "		36.74	60.40	
3911	"	John Hinson, Chadbourn		54.83	38.62	
6547	" top layer	A. H. Hicks, Whiteville		56.35	30.63	0.30
6548	" second layer	" " "		52.07	37.53	0.30
8260	Shell marl	M. Folly, Aberdeen	0.91	34.87	64.47	0.00
8585	Marl	E. L. Applewhite, Applewhite	0.32	31.92	61.07	0.50
2750	Phosphate nodules	R. D. Sessions, Whiteville	7.72	50.88	0.80	20.44
2754	" "	" " "	0.37	52.15	9.43	32.53
2649	Phosphate	" " "	0.23	51.19	10.91	23.97
2752	Small nodules	Gen. W. G. Lewis, Goldsboro	0.89	10.56	11.66	61.12
3398	Phosphate rock	D. S. Cowan, Robeson		38.99	7.67	25.12
	Craven Co.					
278	Limestone	R. A. Russell, Cobton	12.66	6.68	68.42	
428	Marl	Jno. A. Jackson, Vanceboro		29.62	59.02	
506	"	Chas. B. Stubbs, "		74.95	12.13	
523	Earth	Henry Powell, "		15.48		
644	Marl	O. C. Noble, "	1.94	88.55	3.00	
659	"	C. E. Mallett, Riverdale	0.94	77.02	16.55	
721	"	Geo. Allen, Newbern	16.66	40.06	12.38	trace.
1119	"	L. Harvey, Kinston	19.87		71.76	
1139	"	Geo. Green, Jr., Newbern		60.14	35.00	0.53
1297	"	Geo. Allen & Co., "		43.01	49.50	
1952	"	J. Y. Brice, Charlotte		31.17	62.14	0.50
2153	" top stratum	D. Reid, Newbern		50.06	37.78	
2154	" 2d stratum	" "		54.05	44.78	
2155	" top stratum	" "		16.76	80.21	
2156	" 2d stratum	" "		29.79	64.35	1.09
2157	" 3d stratum	" "		11.54	84.54	1.09
2855	White shell marl	K. R. Jones, Newbern		8.13	90.18	trace.
2859	White marl	Geo. Allen & Co., Newbern		93.52	2.50	
2860	White marl	" " " "		23.20	64.38	trace.
3241	Blue marl	J. Y. Brice, Charlotte		74.30	15.21	2.73
4504	Marl	N. A. Pursser, Vanceboro	9.15	38.88	48.20	0.20
3767	Yellow marl	L. J. Moore, Newbern	0.06	25.75	68.30	2.00
4033	White marl	J. A. Jackson, Vanceboro		8.29	89.28	0.50
4204	Yellow marl	J. Y. Brice, Charlotte		55.25	36.71	1.00
4652	Marl	G. V. Chapman, Maple Cypress	13.85	29.95	50.13	trace.
6334	"	Wm. B. Lane, Newbern		33.78	60.12	0.31
6414	"	Watson & Daniels, Newbern			12.65	0.54
6506	"	J. B. Gardner, Maple Cypress		35.29	45.90	small am't.
6507	"	J. B. Gardner, Maple Cypress		19.17	72.78	trace.
6508	"	" " " "		24.79	67.32	small am't.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
6523	Marl	Watson & Daniels, Newbern	.....	8.73	87.16	trace.
6524	"	" " " "	.....	16.80	78.19	trace.
6526	"	" " " "	.....	5.63	90.98	0.50
6527	"	" " " "	.....	7.23	88.25	0.25
6528	"	" " " "	.....	16.17	79.00	trace.
8253	"	Andrew Jackson, Vanceboro	2.36	77.84	10.62	trace.
8349†	Calcined marl	G. L. Hardison, Thurman	3.59	69.18	14.22	abt.25
8351	Black marl	W. H. Worth, Raleigh	3.42	73.30	16.33	2.00
	Cumberland Co.					
1116	Blue marl	E. J. Fuller, Fayetteville	13.74	67.18	12.26	0.53
1117	Shell marl	" " "	.....	39.76	55.35	0.47
	Duplin Co.					
456	Marl	W. H. Williams, Warsaw	.....	82.17	2.96	.....
457	"	" " "	.....	47.67	35.50	.....
458	Shell marl	" " "	.....	50.52	31.07	.....
972	Marl	R. J. Williams, "	.....	25.07	63.03	2.35
1127	"	Mord Taylor, Magnolia	.....	19.47	72.80	trace.
1183	"	J. R. Faison, Faison	.....	59.92	38.00	.....
2120	"	Levi Moore, Warsaw	.....	18.81	40.08	1.22
2835	"	J. C. Maxwell, Resaca	.....	68.12	14.84	small am't.
2836	"	" " "	.....	90.83	1.98	"
3197	White shell marl	E. J. Hill, Warsaw	.....	51.97	43.27	5.45
3665	White marl	Dr. Matt Moore, Warsaw	.....	.....	85.91	.....
4321	White shell marl	B. Whitherington, Faison	1.07	14.55	81.25	0.50
4364	Blue marl	" " "	1.27	80.58	8.26	0.25
4365	White marl	" " "	1.48	20.63	74.49	0.25
4373	" "	W. B. Southerland, Rose Hill	0.63	15.41	76.38	0.25
4424	" "	T. S. Kenan, Raleigh	1.10	18.37	71.15	0.95
4425	Green "	" " "	3.70	69.94	1.14	4.69
4165	White "	W. L. Hill, Warsaw	1.30	17.49	72.66	0.50
4675	Marl	Jno. O'Bryne, Kenansville	17.10	70.69	70.60	trace.
5246	"	A. W. Maxwell, Resaca	.....	10.21	83.38	"
5594	Phosphatic marl	G. W. Lamb, Chinquepin	7.03	14.21	74.24	2.74
5595	Marl	" " "	28.04	62.58	2.91	1.65
5647	"	W. B. Southerland, Rose Hill	0.66	7.01	90.74	.....
6146	Phosphatic marl	Daniel Moore, Warsaw	3.13	83.42	.....	6.71
6166	" "	" " "	.....	70.96	1.70	17.18
6435	Marl	A. D. McGowan, Kenansville	2.32	23.40	68.59	trace.
6465	Green marl	Milton Southerland, Wallace	2.74	87.24	1.46	"
6487	Phosphatic marl	" " "	4.37	74.90	2.30	5.09
6493	" "	Daniel Moore, Warsaw	.....	.....	0.82	9.97
6644	Gray marl	D. McL. Graham, Wallace	.....	63.92	22.77	1.65
6645	Blue marl	" " " "	.....	83.20	10.64	1.00
2263	Phosphate	Levi Moore, Warsaw	.....	41.06	4.86	44.03
2334	"	R. M. Middleton, Warsaw	3.75	45.62	4.59	39.86
2335	"	R. M. Middleton, "	2.39	44.73	2.30	39.33
2336	"	R. M. Middleton, "	3.26	49.58	4.98	38.33
2337	"	G. W. Middleton, "	1.79	51.17	5.91	37.28
2338	"	R. M. Middleton, "	0.59	52.00	7.72	32.59
2339	"	A. M. Faison, Raleigh	3.54	47.74	7.96	39.03
2490	"	J. W. Best, Warsaw	1.08	42.96	4.18	42.46
2541	"	W. H. Kornegay, Kenansville	0.86	38.80	4.65	43.94
2580	"	J. W. Best, Warsaw "	0.52	.....	7.77	39.97
2488	"	Daniel Bowden, Bowden's	0.41	50.02	4.72	33.32

† Contains lime as oxide, 2.09 per cent.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
2489	Phosphate	Arthur Weeks, Bowden's	0.40	39.71	4.48	43.29
2474*a*	"	J. W. Murray, Kenansville		42.43	9.45	37.98
2474*b*	"	" " "		59.82	5.25	28.18
2491	"	A. M. Faison, Warsaw	0.56	58.38	2.95	32.67
2492	"	Rufus Bowden, "	0.60	60.58	3.43	28.88
2542	"	G. W. Middleton, Warsaw	1.73	59.47	3.12	28.16
2543*a*	"	R. Middleton, Warsaw	1.57	28.09	3.81	45.16
2543*b*	"	" " "	0.92	28.92	2.43	57.18
2544	"	Jesse Swinson "	0.51	64.97	2.85	23.24
2545	"	J. A. Boyd, "	1.58	48.57	2.95	37.72
2546	"	Kilby Hollingsworth, Magnolia	1.78	40.92	3.56	46.13
2547	"	L. Middleton, Warsaw	1.06	29.46	3.90	54.89
2548	"	A. Hollingsworth, Magnolia	0.41	45.20	4.18	40.09
2549	"	Levi Moore, Warsaw	0.63	37.36	4.96	44.51
2550	Coprolites	R. Middleton, "	1.56	38.82	3.35	46.06
2551	Phosphate	" " "	0.89	33.42	3.02	41.94
2552	"	A. D. Johnson, Kenansville	0.48	58.54	3.41	29.85
2553	"	G. W. McClammy, "	0.53	37.75	4.30	45.29
2554	Fragments of bone, coprolites, rock	J. B. Carr, Kenansville	1.65	3.55	3.94	73.38
2555	Coprolites	A. D. Johnson, "	0.79	20.93	3.83	64.62
2556	Phosphate	A. M. Faison, Warsaw	1.08	39.60	3.01	46.56
2560	"	J. N. Williams, "	0.80	43.11	4.54	42.20
2561	"	A. M. Faison, "	0.58	41.12	3.59	45.05
2562	"	W. C. Carlton, "	1.06	48.13	3.17	39.40
2563	"	W. H. Windows, "	0.23	42.06	3.65	45.16
2564	"	" " "	1.50	48.32	3.50	37.95
2565	"	" " "	0.80	52.52	2.84	31.45
2566	"	" " "	6.10	63.85	1.81	23.05
2632	"	J. R. West, "	0.73	47.26	5.09	35.67
2633	"	Thos. V. Turrence "	0.35	62.91	4.18	25.41
2634	"	A. West, Warsaw	0.73	25.73	7.50	53.75
2635	"	Jesse Swinson, Bowden's	1.51	38.92	5.16	43.29
2636	"	R. W. Boyette, "	0.59	45.72	5.39	38.90
2639	"	L. Aaron, Warsaw	0.55	51.63	4.45	36.70
2648	"	Henry Best, "	0.65	45.92	4.93	39.32
2650	"	J. F. Croom, Magnolia	0.49	49.93	6.52	35.98
2651	"	M. West, "	0.38	44.37	6.50	36.84
2653	"	J. S. Taylor, "	0.98	37.47	6.91	31.67
2654	"	J. R. Wells, "	0.93	46.86	3.64	32.99
2655	"	S. Boone (col.) "	0.97	37.60	5.07	32.64
2656	"	A. S. Colwell "	0.73	59.24	3.11	31.13
2742	"	Alonzo Rich, Faison's	0.86	34.60	5.71	46.19
2743	"	L. T. Hicks, "	0.66	35.76	5.11	43.53
2745	Black rock	C. C. Ricks, "	0.49	43.81	5.36	24.93
2746*a*	Phosphate, white, compact	Lovette J. Lee "	2.07	1.49	12.00	71.82
2746*b*	Phosphate, gray, compact	" " "	2.50	0.05	8.98	76.82
2746*c*	Phosphate, white, gritty	" " "	0.77	32.79	1.45	7.42
2746*d*	Phosphate, gray	" " "	2.70	0.64	7.07	76.54
2746*e*	Phosphate, common black	" " "	0.81	45.91	5.84	36.02
2747	Phosphate	Mrs. M. E. Pass, "	1.05	43.90	5.52	39.99
2749	"	I. R. Faison, "	0.39	58.53	4.09	27.88

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2751	Phosphate	W. G. Lewis, Goldsboro	0.80	15.27	16.71	53.22
2757*a*	Phosphatic marl	" " "	0.34	29.49	52.14	9.98
2757*b*	" "	" " "		15.27	16.71	53.22
2801	" "	Spiers Lanier, Kenansville	1.07	36.98	16.07	24.67
2802	Phosphate	John Castine, "	0.73	41.24	4.93	42.79
2803*a*	Phosphate rock	Robert James, "	0.38	42.17	46.69	2.91
2803*b*	" "	" " "		6.33	64.46	19.23
2804	" "	" " "	0.34	22.41	59.55	10.50
2805	" "	" " "	0.33	40.66	53.94	1.79
2806	" "	D. J. Middleton, Warsaw	1.48	61.66	2.89	29.12
2807	" "	" " "	0.97	43.21	4.54	44.29
2808	" "	J. B. Pearce, "	1.00	35.10	7.48	45.12
2809	" "	D. I. Woodward, "	0.66	30.44	6.30	53.03
2810	" "	" " "	0.39	36.59	6.30	45.78
2811	" "	J. W. Best, "	0.42	23.95	2.04	20.54
2812	Phosphatic marl	Wm. A. Faison, "	0.49	46.40	5.25	36.08
2815	Phosphate rock	Wm. Boyette, "	0.90	54.75	3.30	32.55
2816	Blue marl	Ransom Middleton, "	0.65	81.59	1.55	9.89
2817	White shell marl	" " "	0.29	46.92	37.78	8.58
2821	Phosphate rock	John Fredricks, "	0.28	68.06	3.64	23.03
2822	" "	W. H. Sloan, Chinquepin	0.36	45.16	4.57	trace.
3100	" "	John Fredricks, Warsaw	0.27	44.48	6.56	38.40
4423	" "	Stephen Graham, Kenansville	0.23	63.16	3.80	25.54
	Edgecombe Co.					
34	Marl	K. P. Battle, Chapel Hill	24.00			1.48
474	"	J. R. Thigpen, Tarboro	3.90	47.80	21.44	0.21
502	Shell marl	Jesse Mercer, "	1.48	72.96	16.24	2.85
513	" "	J. R. Thigpen, "	0.66	14.73	62.80	0.78
626	Marl	" " "	6.73	46.61	12.60	
627	"	" " "	4.52	56.22	26.70	2.43
628	"	" " "	0.61	24.14	51.48	2.88
629	"	" " "	0.66	37.33	35.45	1.26
660	"	John S. Dancy, "	2.32	81.41	trace.	
984	"	J. R. Thigpen, "		60.82	15.00	1.35
1205	Black marl	" " "		71.78	21.67	0.64
1206	Yellow marl	" " "		36.98	56.02	0.46
1619	Marl	" " "			20.24	
2618	Yellow marl	J. Lancaster, "		32.32	67.87	1.59
2865	Marl	M. Battle, "			trace	0.76
3075	White shell marl	T. W. Battle, Rocky Mount	9.95	74.86	10.57	trace.
3076	Blue marl	" " " "	11.93	81.59	1.78	"
3154	White shell marl	" " " "	3.87	72.85	16.64	"
3468	Blue marl	" " " "	1.01	84.98	9.13	2.96
3539	Clayey marl	E. V. Zoeller, Tarboro	4.88	72.24	12.67	3.46
3540	White shell marl	" " "	7.32	71.97	14.32	1.96
3541	" " "	" " "	1.39	83.97	5.35	4.14
3542	" " "	" " "	1.78	79.88	8.57	4.27
4181	" " "	W. R. Cox, Raleigh	1.74	49.91	41.25	2.29
4222	Marl, earthy	C. H. Blocker, Tarboro	2.50	85.91	1.8	0.50
4223	White shell marl	" " "	6.06	84.46	8.07	0.50
4224	Shell conglom'rate	" " "	0.64	47.73	47.17	1.70
4225	White shell marl	E. B. Hodges, "	0.39	42.46	52.43	3.94
4226	Earthy marl	" " "	9.97	77.10	5.11	1.82
4284	Marl, white powd'r	J. M. Mayo, Whitakers	0.80	2.98	94.19	
4394	Yellow marl	C. H. King, Tarboro	0.93	34.04	59.48	0.25
4460	Marl	E. B. Hodges, "	0.35	45.68	49.81	2.82

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4461	Marl	E. B. Hodges, Tarboro	0.56	68.18	23.08	3.27
4486	Gray marl, top lay'r	A. B. Nobles, "	1.89	54.71	8.23	22.32
4487	Black marl, second layer	" " "	11.47	70.96	2.75	4.44
4488	Shell marl, third layer	" " "	2.70	37.41	39.01	11.34
4489	Marl, fourth layer	" " "	1.30	55.98	27.59	7.52
4522	Marl	T. H. Battle, Rocky Mount	0.42	2.86	93.42	.....
4966	Marl, No. 1	G. A. Stancil, " "	7.01	54.94	38.05	.....
4967	Marl, below No. 1	" " " "	58.05	.80	22.04	19.11
5527	Marl	Robert Pitt, St. Lewis	1.12	63.80	27.29	2.99
5528	"	" " " "	0.78	33.18	57.65	2.74
6151	"	Fred. Phillips, Tarboro	1.34	78.60	5.02	1.65
6273	"	E. L. Pitt, St. Lewis	.....	59.73	29.87	3.02
6274	"	" " " "	.....	65.80	25.30	2.88
6303	"	R. E. Pitt, " "	.....	59.84	30.96	2.93
6304	"	" " " "	.....	45.90	46.20	2.21
6554	"	D. H. Barlow, Rocky Mount	.....	56.94	30.70	2 75
3379	Phosphate	A. B. Nobles, Tarboro	1.31	43.32	14.55	21.52
3772	Phosphate, brown rock	" " "	.....	82.69	0.00	7.54
3773	Phosphate, gray rock	" " "	.....	80.76	0.00	9.11
3774	White rock	" " "	.....	62.82	1.22	25.43
	Franklin Co.					
4908	Marl	C. O. Durant, Youngsville	.....	57.52	33.21	0.53
4909	"	" " "	2.86	12.98	84.16	.....
	Greene Co.					
257	Marl	Ben. S. Hardy, Hookerton	2.00	37.36	59.40	0.39
258	"	John Sullivan, Snow Hill	2.50	47.10	41.80	2.86
2320	" light color	Levi H. Mewborne, " "	2.87	94.87	4.02	0.76
2321	" gray	" " " "	4.82	88.29	2.41	1.81
2322	Dark green marl	" " " "	0.37	60.98	4.73	24.82
2577	Marl (near surface)	" " " "	.....	64.13	2.18	28.58
4285	White shell marl	E. C. Blount, Willow Green	2.92	56.66	25.27	3.91
4359	Blue marl	Jno. P. Gray, Snow Hill	4.29	59.74	.25	19.84
4938	Marl	" " " " "	59.47	32.78	7.75	trace.
5717	"	B. T. Mooring, Jason	4.62	80.88	2.59	3.80
	Halifax Co.					
2571	Marl	R. H. Smith, Scotland Neck	.....	48.94	8.03	4.95
2572	"	" " " "	.....	50.79	36.09	small am't.
2573	"	" " " "	.....	77.48	16.10	"
2574	"	" " " "	.....	89.39	0.64	"
2575	"	" " " "	.....	44.19	43.34	4.21
2765	"	J. R. Tillery, Tillery	0.39	8.13	81.01	small am't.
3355	White shell marl	Wm. E. Fenner, Halifax	12.80	30.90	39.39	3.49
3403	Blue marl	H. B. Moore, Palmyra	.....	52.22	32.84	1.00
4413	" "	Ashley Wilkins, South Gaston	.....	71.72	10.12	3.24
3763	White shell marl	E. T. Branch, Enfield	0.75	39.29	51.52	1.00
3764	Shell marl	John S. Gregory, Halifax	1.03	52.20	32.37	3.60
	Hertford Co.					
2211	Marl	Tyrone Spiers, Como	.....	65.82	23.35	.....
3696	Shell marl	T. H. Debnam, Winton	.....	65.53	8.02	0.50
6408	Marl	John Brewer, Murfreesboro	.....	.....	40.96	trace.

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6409	Marl	John Brewer, Murfreesboro	.....	.....	33.53	0.54
6410	"	" " "	.....	.....	36.92	0.54
6456	"	J. M. Wynn, "	0.69	26.27	61.66	0.45
6457	"	" " "	2.22	45.32	46.58	0.42
8235	"	J. C. Drake, Lotta	.....	.....	33.60	trace.
	Johnson Co.					
2937	White marl	H. N. Bizzle, Glenwood	.....	38.85	54.41	trace.
	Jones Co.					
259	Marl	H. C. Koonce, Comfort	0.92	4.80	88.70	trace.
260	Phosphatic marl	C. J. Mattock, Pollocksville	0.83	25.90	66.40	4.33
261	" "	" " "	0.73	25.50	65.40	3.63
262	Marl	Frank Foy, Pollocksville	0.60	29.60	61.40	2.79
654	"	A. T. Uzzell, Tuckahoe	1.75	26.33	61.81	.....
653	"	" " "	1.21	54.09	38.55	.....
2425	Phosphatic marl	A. P. Barrow, Pollocksville	0.77	46.36	39.94	5.61
2426	Marl	" " "	0.50	20.34	71.08	small am't.
2584	"	W. A. J. Pollock, Kinston	.....	.....	.....	trace.
2585	"	" " "	.....	14.18	79.83	small am't.
2586	"	" " "	.....	39.90	54.19	"
2587	"	" " "	.....	27.78	60.71	"
2588	"	" " "	.....	2.76	98.06	"
4468	Blue marl	L. Harvey, "	3.50	25.71	71.76	0.50
4618	Marl	W. M. Jones, Cary	.....	63.76	32.21	2.18
6405	"	C. H. Foy, Kinston	.....	.....	88.25	3.27
6406	"	" " "	.....	.....	4.98	0.54
3101	Phos. nodules	W. G. Lewis, Goldsboro	0.64	7.09	18.42	47.50
	Lenoir Co.					
433	Shell marl	S. E. Hodges, Falling Creek	.....	44.81	45.08	.....
434	" "	" " " "	.....	.....	69.69	18.47	.....
435	Clay marl	" " " "	.....	57.27	32.07	.....
436	Shell marl	Noah Rouse, La Grange	.....	12.52	74.05	.....
437	" "	" " "	.....	17.51	58.32	.....
438	Clay "	B. F. Herring "	.....	84.27	0.43	.....
440	Shell marl	Thomas Dawson, "	.....	25.32	62.87	.....
645	Marl	S. J. Sutton, "	0.81	39.51	52.52	.....
658	Marl	" " "	1.33	48.97	42.02	.....
1340	Ground oyster shells	L. Harvey, Kinston	.....	.....	88.05	trace.
1637	Phosphatic marl	E. S. Broadway, Kinston	0.88	78.20	14.90	3.20
1645	Marl	E. Grady, Kinston	0.69	10.80	83.90	0.91
2162	"	Seth West "	.....	25.84	59.93	1.09
2209	Phosphate	H. O. Hyatt, "	.....	.....	.....	40.67
2427	Marl	W. G. Lewis, Kinston	0.40	9.34	87.67	.....
2428	"	" " "	0.51	8.84	89.06	.....
2429	"	" " "	0.36	8.38	89.10	.....
2430	"	" " "	1.08	41.76	52.03	.....
2431	"	" " "	0.49	44.37	51.87	.....
2432	"	" " "	3.90	82.59	1.89	3.72
2433	"	" " "	0.25	44.06	55.14	2.01
2434	"	" " "	3.81	84.18	3.43	3.65
2435	"	" " "	2.61	80.25	8.41	0.74
2478	"	W. B. Nunn, "	1.59	93.10	0.39	.....
2953	"	G. E. Miller, "	.....	49.75	43.83	very small.

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3189	Ground shell	Harvey & White, Kinston			73.85	0.05
3245	White shell marl.	L. J. Moore, "	0.40	5.81	87.64	trace.
4467	White marl	L. Harvey, "	1.43	89.10	5.44	
3658	White shell conglomerate	H. O. Hyatt, "	0.08	36.25	59.14	2.10
4741	Marl	A. B. Nobles, "			48.58	1.48
4837	Marl bed clay	A. J. Kilpatrick, "		87.59	.18	2.99
4838	Gray marl	" " "		45.84	33.00	2.79
4839	Shell and sand	" " "		51.69	27.06	5.25
4840	Green sand	" " "		76.36	1.48	5.87
5370	Rock	" " "			81.50	0.70
6041	"	B. F. Sutton, La Grange	15.81	72.48	5.25	1.87
6162	"	J. M. Kilpatrick, La Grange			24.21	1.42
6837	"	P. H. Mewborn, Kinston	2.59	80.52	5.85	trace.
	Martin Co.					
2277	Marl	Wm. Slade, Williamston			62.64	28.21	
2286	Shell marl	N. S. Peal, "			70.33	23.21	
2885	Marl	Amos Robinson, Everett's			61.20	27.95	trace.
2886	Rock marl	" " "			48.61	21.95	trace.
	Montgomery Co.					
8733	Marl	J. W. Thompson, Raleigh	0.72	13.53	80.70	trace.
	Nash Co.					
681	Marl	T. P. Braswell, Battleboro	23.61	64.59	7.74	
2625	Ground marl	J. H. Ennis, Raleigh			49.20	42.39	1.83
3587	White marl	W. E. Philips, Battleboro			66.18	22.69	1.96
	New Hanover Co.					
410	Blue marl	Cronly & Morris, Wilmington			67.42	23.76	0.39
411	Stone marl	" " "			45.34	52.28	0.73
412	Blue marl	" " "			34.22		51.89
413	Shell conglomerate	" " "			14.92		59.37
507	Marl	" " "			74.77	10.00	
508	Blue marl	" " "			66.50	21.13	1.15
509	Phosphatic rock	" " "			48.12	35.11	7.04
510	" "	" " "			42.82	48.39	10.96
511	" "	" " "			18.32	74.53	6.90
879	Blue marl	Fred. D. Thorn, "	0.52	24.23	69.17	
1289	Marl	W. C. Kerr, Raleigh			71.26	18.08	0.78
1981	Nodule	T. D. Hogg, Raleigh	0.85	22.07	42.12	20.50
1982	Conglomerate	" "	0.49	33.52	20.45	33.97
1983	"	" "		3.04	90.70	1.46
1994	"	" "				13.40
2029	Nodule	" "	0.41	43.66	34.55	19.99
2100	"	S. W. Noble, Wilmington	0.40	3.25	51.34	31.59
2101	Conglomerate	" "	0.39	16.59	67.47	4.15
2102	Nodules	" "	2.00	31.66	15.94	42.09
2103	Conglomerate	" "	8.54	42.48	10.12	26.64
2104	"	" "	0.61	35.48	51.81	6.40
2132	Nodules (mixture)	T. D. Hogg, Raleigh				30.90
2231	Burned rock	" "		32.29		15.11
2250	Phosphate	" "		16.76		6.89
2251	"	" "		36.53		20.04
2333	Ground conglomerate	" "		23.37	64.26	11.16
2344	Coarse nodules left on sieve, burned	" "		31.08	*32.69	28.90

*Lime as oxide and carbonate combined.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
2345	Sifted from conglomerate burn'd	T. D. Hogg, Raleigh	.....	22.49	*46.16	6.76
2422	Phosphatic marl	Cronly & Morris, Wilmington	....	22.74	16.14	6.17
3187	Conglomerate	C. M. Hawkins, Raleigh	6.56	15.66	63.02	14.02
3261	Phosphate	P. H. Andrews, "	0.56	22.31	.....	38.16
3417	"	P. M. Wilson, "	.....	.....	.....	17.15
3418	"	" "	.....	.....	.....	19.61
3536	Ground rock	Bernardt & Co., Pioneer Mills	0.57	18.44	65.77	11.73
3548	Phosphate	C. M. Hawkins, Raleigh	0.65	29.09	22.28	39.79
2775	Ground phosphate	N. C. Phos. Co., "	0.28	.....	.....	11.09
3795	" "	T. Ivey, Ashpole	0.98	18.47	56.60	13.69
3854	" "	T. D. Hogg, Raleigh	.....	.....	.....	10.42
3926	Blue marl	" "	.....	44.03	50.05	1.00
3930	Phosphate nodules	N. C. Phosphate Co., Raleigh	0.80	35.05	38.92	13.50
4234	Phosphate	C. M. Hawkins, Raleigh	.....	43.38	.....	13.10
4235	"	" " "	.....	54.52	.....	1.79
4594	"	Marmaduke Hawkins, Raleigh	.....	.....	59.34	19.36
4595	"	" " "	.....	.....	16.17	64.65
4604	Ground phosphate	P. M. Wilson, Raleigh	.....	.....	61.03	9.42
4605	" "	" " "	.....	.....	76.74	6.71
4606	" "	" " "	.....	.....	78.15	6.31
4884	Nodules, finest	" " "	.....	.....	13.01	10.25
4885	" medium	" " "	.....	.....	8.44	43.17
4886	" coarser	" " "	.....	.....	8.76	37.19
4933	Ground phos., fine	" " "	.....	.....	.....	37.83
4934	" coarse	" " "	.....	.....	.....	33.81
5714	Phosphate	C. M. Hawkins, "	....	68.54	0.00	11.87
6153	Marl	H. W. Malloy, Wilmington	2.26	25.36	56.39	0.67
	Northampton Co.					
3290	Blue marl	J. E. Stancil, Margarettsville	2.05	87.13	3.14	trace.
8718	Marl	W. J. Edwards, Severn	3.88	45.63	33.67	0.20
	Onslow Co.					
2491	Phosphate rock	David Sandlin, Richlands	....	12.27	60.62	12.24
2495*a*	Coprolites, white	J. M. F. Brock, "	....	53.91	4.57	31.50
2495*b*	" dark	" "	.....	4.95	88.94	2.30
2496	"	L. Franks, "	....	25.36	9.77	50.60
2590	Phosphate	Geo. Allen & Co., Newbern	3.04	1.35	7.73	74.03
2818	Marl	A. H. Rodes, Tar Landing	0.40	47.86	4.48	37.79
2819	"	Allen Murrill, "	0.58	42.25	6.20	37.22
2820	Phosphate rock	Chris. Stevens, Jacksonville	0.29	44.64	7.91	35.78
2832	Yellow marl	Geo. Allen & Co., Newbern	....	8.13	81.01	s.amt.
2833	Gray marl	" " "	.....	2.96	92.60	.....
4233	Yellow marl	J. L. Nicholson, Richlands	.....	56.96	0.68	5.67
6464	Shell marl	Geo. R. Venters, Green Branch	0.48	50.62	42.28	4.61
6942	Phosphate	H. W. Nixon, Jacksonville	.....	.....	.....	13.05
8623	Marl	H. D. Murrill, Jacksonville	0.36	26.79	66.49	1.15
	Pasquotank Co.					
4821	Marl	R. B. Creecy, Elizabeth City	9.84	62.27	26.89	1.00
	Pender Co.					
1278	Limestone	French Bros., Rocky Point	.....	.....	87.64	.....
1279	Limestone	" "	.....	.....	92.58	.....
2221	Marl	Nicanor Powers, S. Washing'n	21.50	66.08	9.39	.....
3747	Marl	" "	.....	.....	44.71	1.00
2097	Nodules	French Bros., Rocky Point	0.86	18.50	39.04	25.34
2098	"	" "	1.33	20.02	42.12	22.68
2099	Conglomerate	" "	0.51	20.28	57.29	11.81

*Lime as oxide and carbonate.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
2109	Nodules	French Bros., Rocky Point				13.73
2130	Nodules	" "				19.62
2222	Conglomerate	" "		24.96	54.71	16.42
2223	No. 2222 after burning	" "		36.49	*37.52	20.34
2250	Conglomer. burn'd and sifted	" "		16.76	*60.00	6.89
2251	Nodules from No. 2250	" "		36.53	*38.36	20.04
2267	Phosphate	Geo. Z. French, "				11.76
2268	"	" "				41.24
2657	"	J. Alderman, Duplin Road		56.95	6.70	29.36
2757	Phosphate rock	C. P. Moore, Point Caswell	0.32	61.96	4.32	21.02
2758	Nodules	C. P. Moore, "	0.42	24.77	15.55	47.50
3239	Phosphate rock	W. G. Lewis, Goldsboro	1.18	22.75	16.06	43.72
3526	Coprolite	French Bros., Rocky Point	0.41	18.26	57.95	11.09
3753	Phosphate rock	" "				4.36
3865	White marl	Dr. Matt. Moore, Warsaw			85.51	
4429	Phosphate rock	G. Z. French, Rocky Point				49.48
4430	" "	" "				54.76
4536	Phosphate rock	N. W. Powers, S. Washington		51.46		10.06
5292	Phos. conglomerat'	Geo. Z. French, Rocky Point			63.09	9.95
5293	Phosphatic lime	" "			†11.33	7.74
6942	Phosphate	Hill W. Nixon, Topsail				13.05
	Perquimans Co.					
2576	Marl	Joseph Moore, New Gardner		36.66	52.87	
	Pitt Co.					
1330	Marl	W. H. Cox, Greenville			68.06	
1331	"	E. A. Johnson, Johnson's Mills	1.26	28.50	63.86	0.30
2883	Blue marl	Allen Warren, Greenville		15.81	77.54	trace.
2884	White shell marl	" "		59.41	35.77	"
2998	Blue marl	C. C. Kirkman, Coxville		81.10	10.21	"
2999	"	" "		89.09	5.93	"
3003	Blue with white shell marl	J. G. Shephard, Farmville		73.91	13.99	6.01
3119	While shell marl	G. W. Venters, Calico		16.41	74.61	small am't.
3120	Marl	" "		30.71	53.30	trace.
3280	Shell marl	Jos. H. Saunders, Pactolus	1.12	44.20	42.73	6.47
3554	Blue marl	L. B. Burney, Johnson's Mills		52.41	40.73	1.84
3555	"	" "		87.09	2.35	1.54
3556	"	" "		78.61	12.99	0.78
4217	White marl	Joe M. Dixon, Johnson's Mills		35.71	27.14	0.80
4219	Shell marl	R. S. Tucker, Raleigh		62.72	26.75	4.00
4220	"	" "		65.64	12.57	8.00
4221	"	" "		69.49	14.67	2.00
4278	White marl	J. W. Quinerly, Johnson's Mills	1.09	41.45	51.13	0.25
4459	Marl	W. R. Williams, Falkland	1.80	83.00	6.91	1.09
4527	Marl	T. W. Stokes, Johnson's Mills	10.44	28.11	53.70	0.50
4943	Marl	Allen Warren, Greenville	15.30	47.41	37.29	trace.
5596	Phosphatic marl	W. B. Dawson, Conetoe	1.92	59.77	23.52	4.22
8047	Blue marl	Fred F. Brooks, Grifton	1.65		13.24	trace.
8148	Red marl	" "	0.70		47.90	6.00
8350	White shell marl	W. H. Worth, Raleigh	0.64	8.91	85.46	1.00

* Lime as oxide and carbonate combined. †Lime as oxide and hydrate—46.65

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
	Robeson Co.					
1434	Marl	C. W. Dabney, Raleigh	1.06	54.75	35.03	trace.
1740	Marl	E. P. Higby, Lumberton	-----	63.40	21.01	-----
3882	White shell marl	T. Ivey, Ashpole	-----	51.86	41.78	2.00
4914	Marl	A. C. Oliver, Fair Bluff	-----	34.42	60.14	2.93
	Sampson Co.					
1126	Phosphatic marl	A. S. Colwell, Harrell's Store	----	74.58	5.87	*12.16
2131	Green sand	A. S. Colwell, Harrell's Store	-----	92.19	1.20	0.91
2383	Marl	A. J. Smith, Taylor's Bridge	-----	59.73	26.64	1.50
2384	"	" "	----	33.71	56.17	0.75
2423	"	A. S. Colwell, Harrell's Store	1.85	72.71	8.82	3.93
2424	"	" "	0.40	16.95	75.69	-----
2534	Phosphatic marl	W. M. Killett, Clinton	0.80	85.23	1.45	7.31
2706	Marl	A. J. Smith, Taylor's Bridge	....	52.60	41.87	trace.
3538	"	J. R. Harris, Owensville	7.32	72.99	4.64	0.64
6373	Marl rock	T. W. Underwood, Newton Grove	-----	35.42	55.86	0.78
7881	Marl	R. G. Morrisey, Clinton	----	------	40.99	0.50
2557	Phosphate	W. H. Faison, Warsaw	0.58	30.47	4.84	49.47
2558	"	Edward Mann, "	0.46	52.00	3.93	33.60
2559	"	A. J. Daniels, "	0.34	42.79	4.20	42.00
2658	"	F. Johnson, Harrell's Store	0.42	47.18	5.91	28.09
2659	"	J. F. Taylor, "	0.33	47.41	5.27	38.31
2660	"	Lewis Highsmith, "	0.22	70.78	4.20	20.24
2661	"	T. N. Fennel, "	0.55	54.96	3.91	32.05
2662*a*	Fossil bone	" "	2.62	1.58	9.55	69.55
2662*b*	Phosphate rock	" "	0.46	51.75	4.52	32.53
2663	Phosphate	R. P. Matthis, Clinton	0.34	49.34	4.66	33.62
2664	"	W. K. Pigfords, "	1.19	29.41	5.68	38.09
2665	"	L. A. Powell, "	0.39	51.93	6.43	29.93
2666	"	Allen Whitfield, "	0.92	50.42	1.86	35.52
2667	"	J. H. Pugh, "	0.63	45.99	4.07	36.33
2668	"	Louis M. Boykin, "	4.42	58.03	0.98	12.99
2669	Coprolites	Spencer Merritt, "	0.41	32.16	3.91	50.73
2670	"	J. D. Carter, "	0.51	44.99	5.25	37.70
2671	"	J. H. Pugh, "	0.56	36.04	4.71	44.82
2672	"	L. A. Powell, "	0.47	52.53	5.68	32.22
2673	"	D. B. Nicholson, "	0.39	53.43	6.43	29.47
2739	Black massive rock	J. B. King, Faison	0.56	60.29	3.52	26.52
2740	Phos. rock massive	A. H. King, "	0.87	42.97	4.11	39.51
2741	Gray phos. massive	J. C. Hobbs, Hobbs Cross Roads	0.14	61.54	2.68	28.16
2753	Phosphate rock	F. M. Herring, Clinton	0.42	58.68	4.18	27.42
2814	Coprolites	John D. Carr, "	0.49	8.06	18.66	54.01
	Stokes Co.					
4023	Limestone	L. H. Hill, Germantown	-----	------	86.47	------
4517	"	W. A. Lash, Walnut Cove	-----	43.58	53.05	------
4518	"	" "	----	------	49.58	42.74	------
	Wayne Co.					
101	Marl	J. J. Whitehead, Raleigh	1.00	72.26	13.90	0.93
122	"	" "	4.52	19.34	74.54	0.30
124	"	B. F. Arrington, Goldsboro	4.05	51.28	38.27	1.40
125	"	" "	----	9.52	83.64	trace.
126	"	" "	------	13.06	81.02	------
2242	"	George C. Moore, "	------	59.75	29.72	----
2697	"	N. W. Musgrove, "	------	75.67	18.12	1.00

* Potash, .76 per cent. Considerable ferrous oxide is present and renders this marl injurious.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
3407	White shell marl	J. W. Isler, Goldsboro	1.11	51.53	42.85	1.00
3159	Marl	J. H. Parks, "		81.36	2.14	2.38
4960	"	T. B. Parker, "	1.87	57.19	40.94	trace.
4961	"	" "	7.30	51.22	41.48	"
6614	Lime rock	Jno. R. Smith, "		53.15	40.03	10.90
7154	Marl	J. P. Cox, Walter		74.95	14.77	1.00
7254	"	" "		35.74	36.80	11.32
	Wilson Co.					
468	Blue marl	F. M. Roundtree, Wilson	1.07	78.36	21.64	
499	Blue clay marl	Jas. Bryant, Wilson	4.30	81.90	13.80	
500	Shell marl	" "		16.48	71.59	
671	Phosphatic marl	W. P. Carraway, Wilson	1.71	19.90	38.87	4.45
673	Marl	" "	3.58	63.37	12.42	
1013	Phosphatic marl	Jesse Mercer, Toisnot	1.38	85.56	4.10	7.38
3096	Yellow, earthy mrl	A. G. Brooks, Black Creek		86.07	0.82	1.53
3097	" "	" "		89.96	2.07	1.64
3098	White shell marl	" "		86.24	2.53	1.46
3099	" "	" "		80.19	4.21	1.57
4203	" "	H. Winstead, Toisnot	2.26	84.68	8.40	0.50
4787	Marl	A. G. Brooks, Black Creek	0.62	89.30	4.23	1.96

THE MANUFACTURE OF ACID PHOSPHATE FROM MINERAL PHOSPHATES.

While the beneficial effects of bone manure has been known from early times, its value as a plant food did not begin to be thoroughly appreciated until after the year 1840, when Liebig first published his theory of plant nutrition. His suggestion at this time that the phosphate of lime in bones could be converted into a valuable fertilizer by treatment with sulphuric acid, and the carrying of this suggestion into practical effect by Sir John B. Lawes, brought into existence the chemical fertilizer and phosphate industry, which has gradually been developed until at the present time it has attained enormous proportions. The world's estimated production of raw phosphates in 1880 was about 500,000 tons, while in 1890 it was about 1,303,000 tons, an increase in ten years of over 160 per cent. Of this enormous amount, the United States alone produced nearly one-half, the principal sources of which were from the beds in South Carolina and Florida.

The greater part of this raw material was consumed in the manufacture of superphosphates, or acid phosphates, which means a production in 1890 of over 2,000,000 tons. The increasing demand for phosphate manures during the past few years has not only stimulated the discovery and exploration of new fields, but large sums of money have been expended for erecting extensive and costly plants for the manufacture of these materials. Most of these establishments are not only equipped with every facility for acidulating and mixing fertilizers, but are also provided with large lead chambers for the manufacture of sulphuric acid, one of the essential constituents of acid phosphate. Improved machinery, the substitution of iron pyrites for sulphur in the manufacture of sulphuric acid, and closer competition, both with reference to the producers and manufacturers, has brought the price down to a reasonably low basis. It would not, therefore, be either practicable or profitable for the average farmer to endeavor to engage in the acidulating of ground phosphate for home consumption, but he should at least have some knowledge of their manufacture, composition and value. While the manufacture of acid phosphate from mineral phosphates is neither very complex nor difficult, the process is not very generally understood. The ever-varying composition of the raw materials makes it impossible, even for the experienced manufacturer, to obtain the best results without the assistance of a chemical analysis. It is, therefore, not only necessary to have a certain amount of practical experience to conduct a business of this kind successfully, but also some knowl-

edge of chemistry and chemical methods is of the utmost importance. There are several phosphates found in nature, but the one most used in the manufacture of fertilizers is the tri-calcium phosphate ($Ca_3O)_3 P_2 O_5$, which is made up of three molecules or parts of lime (Ca O) and one molecule or part of phosphoric anhydride ($P_2 O_5$). In this form, phosphate of lime is not soluble in water, and very slowly decomposed by the action of the soil and plant juices. The method for making this material soluble or available as plant food, which is now in universal use, is the same as was first introduced by Liebig, that is, by treating the ground rock with a sufficient amount of sulphuric acid ($H_2 SO_4$) to convert the insoluble phosphate into a soluble or available form. Sulphuric acid, being more energetic in its action than other common acids, has the power of displacing most other acids from their salts and taking their bases to form sulphates. If the crude phosphates were pure tri-calcium phosphate, the chemist could easily calculate the amount of sulphuric acid required for complete reduction, which would be applicable in all cases; but as these materials always contain admixtures of other substances, these impurities must be considered in calculating the amount of acid to be used. The amount of monohydrated sulphuric acid required to make acid phosphate of pure tri-calcic phosphate may be calculated from the following chemical equation:

$$\underbrace{Ca_3 P_2 O_8}_{310} + \underbrace{2H_2 SO_4}_{196} = 2Ca SO_4 + Ca H_4 P_2 O_8.$$

molecular weights.

From this will be seen that 310 parts calcium phosphate requires 196 parts of sulphuric acid for complete reduction, or for every 100 pounds of phosphate 63.2 pounds of pure sulphuric acid must be used; but all mineral phosphates, as already stated, contain impurities which must be considered in calculating the full amount of acid to be used. For instance, by a further calculation of the necessary chemical equations, it is ascertained that 100 pounds of ferric oxide requires 183.8 pounds of pure sulphuric acid.

100 pounds of alumina requires 288.3 pounds of pure sulphuric acid.

100 pounds of calcium carbonate requires 98 pounds of pure sulphuric acid.

100 pounds of magnesium carbonate requires 116.6 pounds of pure sulphuric acid.

100 pounds calcium fluoride requires 125.6 pounds pure sulphuric acid.*

* Florida Experiment Station, Bulletin No. 10.

With the information thus furnished, there should be no trouble in dealing with any phosphate, when the composition is accurately known. For example:

Analysis of phosphate.	Per cent.	*Sulphuric acid required.*	Pounds.
Phosphate of lime	79.40	79.40 × 63.2 =	50.18
Carbonate of lime	5.48	5.48 × 98. =	5.37
Ferric oxide	0.72	0.72 × 183.8 =	1.32
Alumina	3.00	3.00 × 288.3 =	8 65
Calcium fluoride	3.20	3.20 × 125.6 =	4.02
			69.54

The total quantity of pure sulphuric acid required for every 100 pounds of rock of the above composition is found to be 69.54 pounds to bring the insoluble phosphates into a soluble and available form.

The above calculation is based on pure monohydrate sulphuric acid, but the ordinary "*chamber acid*" of the trade contains considerable water and other impurities, for which due allowance must be made. This acid is usually measured with a Beaumé hydrometer, and the strength expressed in degrees Beaumé, which corresponds to the following percentage: *

Degrees Beaumé at 60° F.	Percentage of SO_3 (anhydride).	Percentage of H_2SO_4 (monohydrate).
48	48.70	59.63
49	49.80	61.00
50	51.00	62.47
51	52.20	63.94
52	53.50	65.53
53	54.90	67.30
54	56.00	68.60
55	57.10	69.94

Assuming the acid used to be of 55° B. strength, we refer to the table and find that it contains 69.94 per cent. of pure sulphuric acid. The quantity to be taken as an equivalent of 69.54 pounds of pure acid, is found by the following proportion: 69.94 : 100 :: 69.54 : x, whence x=99.43 pounds. Therefore 100 pounds of the ground rock of the composition given in the preceding example requires 99.43, or practically 100 pounds, of "*chamber acid*" of 55° B. strength.

Thus, by theory, 1 ton of ground rock mixed with 1 ton of acid will produce about 2 tons of first-class acid phosphate. While this is the case with much of the material it cannot be said to apply in every instance. There are certain other elements which affect the operation which can only be obtained by practical experience. It has been found that much depends upon the grinding, for a very finely pulverized rock is much more easily reduced than a coarser material. The presence of iron and alumina to any considerable

* This table is from Dr. F. T. Wyatt's "Phosphates of America," to whom credit should also be given for many points in this discussion.

extent is also a very troublesome factor. It not only takes a very large amount of acid, but when the theoretical amount is added it renders the mass sticky and very difficult to dry. On the other hand, if less than the theoretical amount of acid be used a certain amount will remain insoluble. These difficulties and many others constantly confront the manufacturer in dealing with refractory raw materials, the solution of which must be left to the skill and experience of the practical operator. In England the commercial value is based upon the percentage of water-soluble phosphoric acid, but in this country not only the water-soluble is considered, but also the percentage of phosphoric acid which is soluble in neutral ammonium citrate treated at 65° Centigrade, as well as the insoluble form in some states. The action of ammonium citrate is supposed to be as nearly like the action of the soil and plant juices as can be produced in an artificial way, and hence the term *available* is applied to all the phosphoric acid which is liberated by it, including the soluble form which is readily dissolved by pure water. The average marketable South Carolina rock contains about 60 per cent. of phosphate of lime, and should produce an acid phosphate containing from 13 to 15 per cent. of available phosphoric acid. Select rock from Florida is of a little higher grade, while that of North Carolina and other localities is somewhat inferior in quality.

The use of mineral fertilizers stands no longer on the defensive, as is shown by their tremendous development during the past twenty-five years, while their usefulness is so generally recognized now that their production and manufacture will continue with increased activity in future years.